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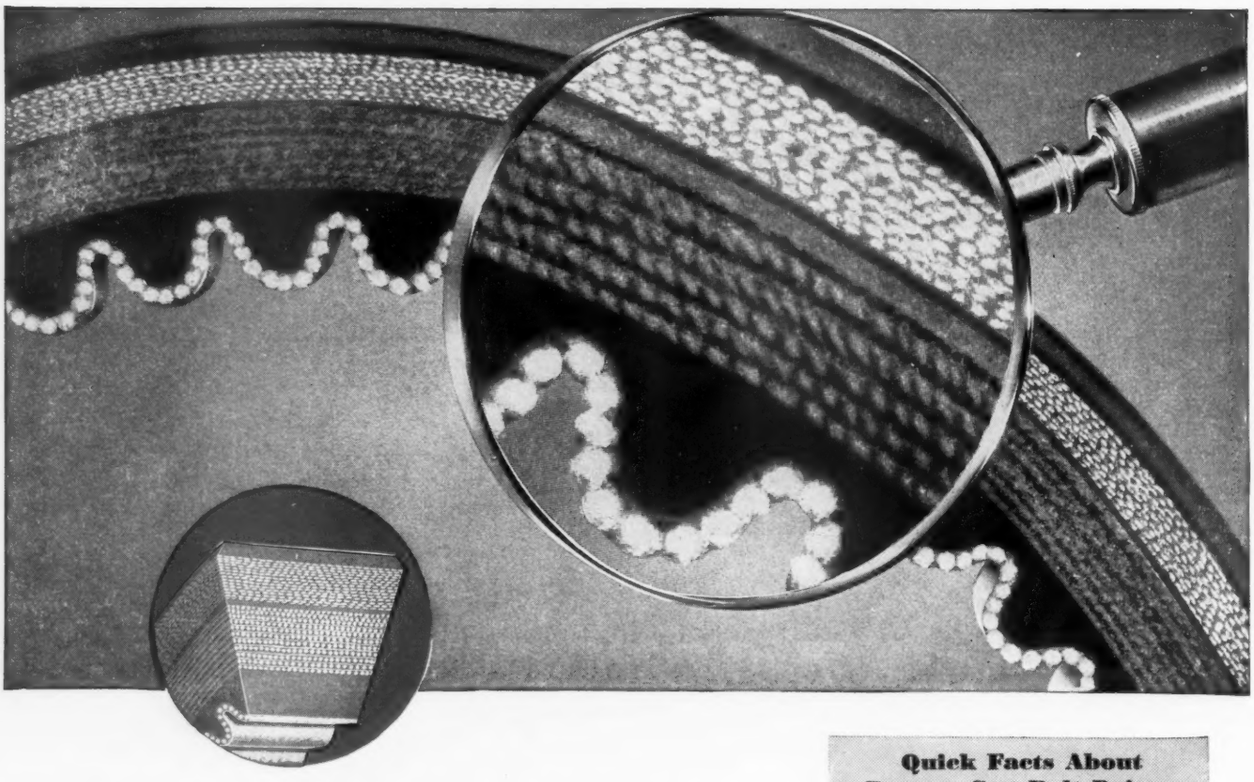
INSIDE A CAISSON 40 FEET UNDERWATER

Greater Gripping Power
with less tension



Sides *die-cut*—not molded—provide another exclusive and important reason for the proved efficiency of Dayton Cog-Belts

A powerful, leech-like grip—less slipping or sliding even with quick starts and stops—less loss of power—less vibration—

—these are some of the many advantages assured by the *die-cut sides* of Dayton Cog-Belts. The raw edges of the die-cut sides contact the sides of the pulley groove and form the driving surface. There's practically no wear. Nor will they ravel. Nor glaze.

Because of this exclusive construction no other V-Belt provides such unfailing gripping qualities—such a steady, uniform flow of power, regardless of speeds—all with less tension, less wear on the bearings.

And in addition to die-cut sides, Dayton Cog-Belts have many other outstanding features. They're the only belts *built to bend*. Because of their cogged inner surface and laminated construction they have far greater flexibility. Even on the smallest pulleys there's no buckling, no distortion, no "squashing" in the pulley groove—*the only V-Belt that combines maximum flexibility with crosswise rigidity.*

And economical, too—cost less to use. They're pre-stretched, so adjustments are seldom necessary. And their *life* is *twice as long* as ordinary belts.

These are only a few of the reasons for the pronounced trend to Dayton Cog-Belt Drives in the power transmission field. We shall be glad to send you all the facts.

THE DAYTON RUBBER MFG. CO.
DAYTON, OHIO

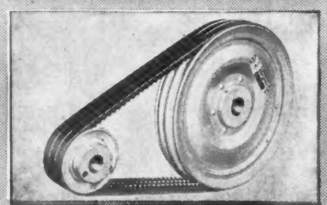
Factory Distributors in Principal Cities and all Westinghouse Electric and Manufacturing Company Sales Offices

Quick Facts About Dayton Cog-Belt Drives

1. Save floor space.
2. *Built-to-bend*—no distortion—no internal heating.
3. Greater gripping power—no slipping or sliding.
4. Stretch removed—fewer adjustments necessary.
5. No dressing or lubrication.
6. Less tension required—easy on bearings.
7. Longer life—belt replacement costs often cut in half.
8. Quiet—Clean—Rugged.

Complete drives—pulleys and belts—in stock. Fractional to 100 H. P.

DAY-STEEL PULLEYS



Investigate the exceptionally low cost of Dayton Cog-Belts with Day-Steel Pulleys

Built to Bend

Dayton
COG-BELT DRIVES

Also manufacturers of Dayton Fan Belts . . . Dayton Red Tube Radiator Hose . . . and the famous Dayton Thorobred Tires and Tubes

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« » EDITORIAL « »

CHOOSING HIGHWAY ROUTES WISELY

FOLLOWING the completion of a new road in Texas, one of the elected officials asked the state highway engineer how long it would last. He had reference to the pavement with which it was surfaced. The reply of State Highway Engineer Gibb Gilchrist was enlightening, if unexpected. "The life of a road," said Mr. Gilchrist, "depends upon its location first, and upon its width second. The type of surfacing used is of tertiary consideration."

There is a growing realization that this appraisal was correct. In other words, no highway, regardless of how it is constructed, will endure unless it goes the right places and follows the best route in going there. Too often in the past roads have been located without taking these things into account. Political expediency, local propaganda, and kindred influences frequently determined where they should go and the courses they should take. Every town of any size along a general route insisted that the traffic pass right smack through its business center, regardless of how much additional mileage it entailed or how much it would slow up through traffic. Most times engineers had the way dictated to them, so they cannot be blamed. But, even where engineering had a voice, the tendency was to follow railroads or previously built roads.

The modern idea is that a road should take the shortest line from a travel-time standpoint that can be constructed in the section to be traversed. Most cities now know that it is better to keep through traffic off their busy streets; and they realize that even when a trunk line by-passes the city limits people who have business with them will turn aside and enter. The theory of thinking highway men is that any town that must depend upon transient trade dumped into its lap has no real reason for existing.

Largely through the instrumentality of aerial surveying, engineers have been enabled to lay out roads which will better serve both present and future needs. By viewing the country from aloft, through the medium of photographs, it is a comparatively easy matter to pick the best available routes consistent with the topography and other controlling features. The resultant savings in time and money are, in the aggregate, enormous. Not only are less materials of construction required, but minutes are cut off the running time of each of the hundreds or thousands of cars that use the roads every day.

A well-made aerial map is the best answer to "the delegation from Jonesville" which is always cropping up to inform the highway department that it would be a calamity to leave its fair city off the new road. Such a map will show, in a manner that defies argument, which route will best suffice in moving people and goods safely, speedily, and economically.

An article in this issue describes how aviation is put to valuable use in locating roads and in various other branches of engineering.

ANOTHER ALPINE TUNNEL?

MAN'S instinct to burrow probably goes back to the time when his forebears lived in caves of their own making. Certainly the urge to dig is persistent. It crops out in every normal boy at a tender age, and the result is a profusion of holes in the back yards and vacant lots of the world. It would be interesting, though of no import, to know whether those youths that exhibit the strongest inclination to explore beneath the surface grow up to become our leading mining, quarrying, and tunneling men.

In any event, the advances in engineering and the continuing development in rock drills and explosives of higher effectiveness have enabled this passion for perforating the earth to be put to increasingly greater practical use. One outcome of all this is a growing number of projected tunnels. Some of the schemes are so ambitious as to be classed as visionary at present, but succeeding generations will likely consider many of them practical and put them through with little ado. There are, for instance, the proposals for bores beneath the English Channel and the Strait of Gibraltar. Both have been shelved temporarily, partly by reason of international complications; but engineers have declared them feasible and some day they will no doubt be dug.

The western part of our own country also promises plenty of opportunities for future human moles to practice their art. More than twenty years ago an enterprising engineer advanced the idea of boring a 14-mile hole through the Continental Divide west of Denver to tap the headwaters of the Colorado River and to divert them to the eastern slope of the Rockies, where thousands of acres of fertile land lie unused because of their aridity. If and when there arises a need for more sugar beets, alfalfa, and grain—a condition that seems far-fetched in view of the existing plethora of these products—rock drills will start biting away at the granite core of the cordillera. The plans are drawn and costs have been closely gauged: all that remains is to convince suppliers of capital that such a tunnel would prove profitable.

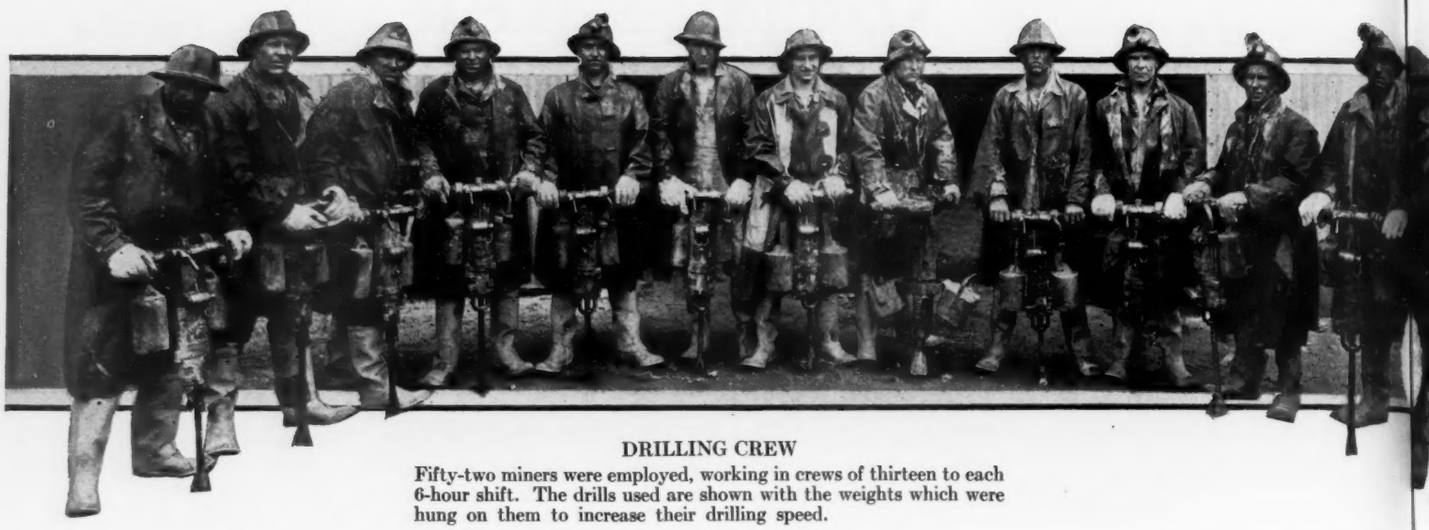
But, even though some of these ideas are a little premature, there is still plenty of work for current tunnelers. Having found the Holland tubes beneath the Hudson River unexpectedly popular with motorists, the states of New York and New Jersey, through the Port of New York Authority, are proceeding to penetrate the ooze of the river bottom with a new passageway.

Meanwhile, from Paris comes word that French and Italian engineers are urging a vehicular tunnel through the shoulders of Mont Blanc. The proposed bore would permit automobiles to follow a direct line from Paris to Rome without going above 4,000 feet. At present they negotiate the Alps by way of Mont Cenis Pass in the summertime: in the winter they must detour along the coast through Nice and Monte Carlo.

The Mont Blanc Tunnel would be a little less than eight miles long, considerably shorter than two railroad bores that now pierce the Alps. If built, it will carry with it the requirements of ventilation and air conditioning. The removal of noxious gases is being practiced in several tunnels, but the element of temperature control is a new one. Investigations indicate that certain sections of the passage would develop temperatures as high as 101°F.

THE COVER PICTURE

THIS photograph was taken as bedrock was reached by one of the eleven pneumatic caissons which were sunk to secure footings for piers of the St. Louis Bridge across the St. Lawrence River which is the subject of the article starting on page 4428. The air pressure corresponding to this depth of 40 feet below the river surface is approximately 18 pounds. As will be noted, the interior of the working chamber is practically dry. This view illustrates one of the unseen uses of compressed air in connection with subaqueous construction. Since Brooklyn Bridge was thrown across the East River, the pneumatic caisson has contributed importantly to virtually ever large bridge undertaking.



DRILLING CREW

Fifty-two miners were employed, working in crews of thirteen to each 6-hour shift. The drills used are shown with the weights which were hung on them to increase their drilling speed.

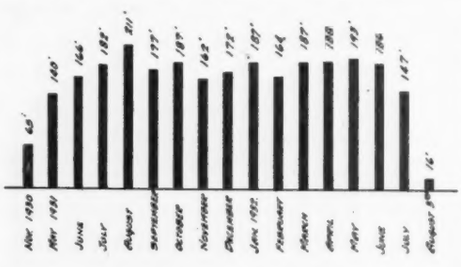
Sinking a Mine Shaft Half a Mile Deep

J. C. SULLIVAN*

SHAFT sinking has become a highly specialized phase of mining operations. Through a combination of careful planning, thorough organization, and the use of efficient modern equipment, continually better records are being made both as regards faster work and lower costs. American mines always have been among the leaders in shaft-sinking efficiency, and their work in late years has sustained their established position. A recent contribution to this creditable record was the sinking of a new shaft to serve the Newport and Bonnie iron mines of the Youngstown Mines Corporation at Ironwood, Mich. These properties, which are on the Gogebic Range, are operated for the owners by Pickands, Mather & Company.

This new shaft, which is the third to be sunk on the property, was required because of deformation of the shaft previously used by subsidence and movement of the ground which inclosed it. The iron-bearing formation, in common with the series of sedimentary rocks in which it occurs, dips at an angle of between 65° and 70° from the horizontal. The original shaft was an inclined one in the footwall and became unusable as the result of a squeezing action set up by shifting and settlement of the overlying ground. In an effort to eliminate the difficulty, a new vertical shaft, known as the Woodbury Shaft, was sunk in 1915-16. It was started at a point about 100 feet from the foot of the surface contact between the iron-bearing horizon and the underlying sedimentary strata. With continued use, however, this shaft was also affected by subsidence and movement of the surrounding rock, and in 1929 preparations were made for the sinking of another shaft. To obviate all possibility of its being subjected to deformation from subsurface movements, it was located in the granite several hundred feet away from the contact with the sedimentary rocks and carried in this granite to its full depth. After careful consideration, a vertical shaft was selected. Although this choice meant more development work in driving underground openings into the ore, its advantages were found to more than offset the hazards involved in running wheeled skips on inclined rails and the greater cost of maintaining a sloping shaft and of hoisting ore through it.

The new shaft is a duplicate of the Woodbury Shaft. Its over-all dimensions are 13 feet 1 inch by 21 feet 1 inch. It has six compartments, consisting of two cage roads, two skip roads, one ladder road, and one pipe road. It was sunk to a depth of 2,665 feet in 444 working days, the average daily progress being slightly more than 6 feet. It is lined with horizontal steel sets made up of 6-inch H-beams hung on 8-foot centers, and interconnected by studdles of 3x5-inch angle irons.



PROGRESS BY MONTHS

The total depth of the shaft is 2,730 feet. After it had been sunk 65 feet, a halt of five months was made while a permanent steel headframe, power house, and other essential structures were erected.

A large-scale map of all the area considered suitable for the purpose was used in determining the site of the shaft. This map was drawn with 2-foot contours and showed all existing roads, tracks, and structures, thereby making it possible to select a location whose topography would be favorable for erecting necessary surface structures, for storing and handling required materials, and for disposing of excavated rock.

It was determined beforehand that all holes would be drilled vertically and arranged around a central hole for them to break to, and it was decided to experiment with different methods of drilling, blasting, and mucking in the first 100 feet of depth. To facilitate this plan, a central 6-inch hole 100 feet deep was drilled at the start with a churn drill. This hole was then filled with sand. Sinking through the overburden began on August 28, 1930, using temporary power, water, and compressed-air facilities. Surface material was removed with a scraper and a 25-hp. electric hoist to a depth of 22 feet, where granite was encountered. The exposed rock surface was then thoroughly cleaned to insure an impervious joint, after which forms were erected for the concrete shaft collar and permanent headframe piers all of which were poured with 428 cubic yards of a 1:3:5 mixture. The collar steel set, supported by a bearing set, was installed with its top flush with the collar and was made rigid to prevent any movement as a result of blasting. A 35-foot temporary timber headframe was erected to serve for the first 100 feet of experimental excavating, and a 50-hp. single-drum electric hoist was set up about 130 feet from the shaft

Drilling was started on October 31, 1930, with two shifts of six miners and one foreman each. The primary purpose of this initial work

*Mining Engineer, Pickands, Mather & Company, Newport Mine.

THE HEADFRAME

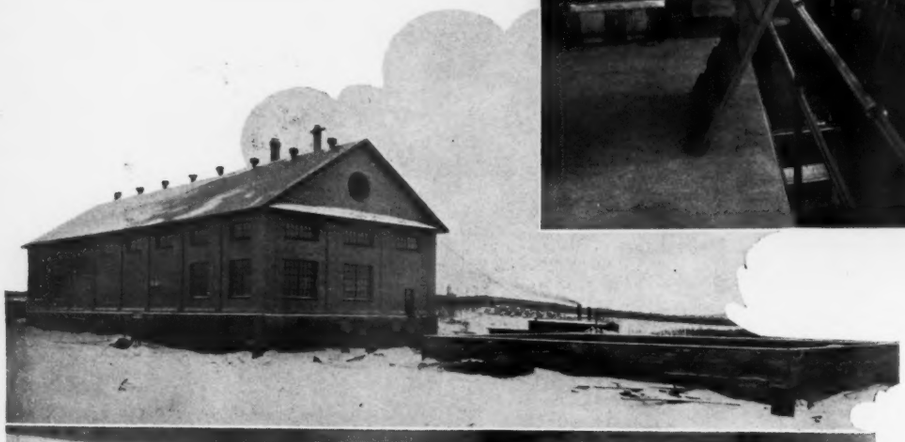
This is a permanent all-steel structure for use in connection with the mining operations through the shaft. The top sheave wheels are 132 feet above the collar. This view, made during its construction, also shows the partly completed temporary steel-sharpening shop.

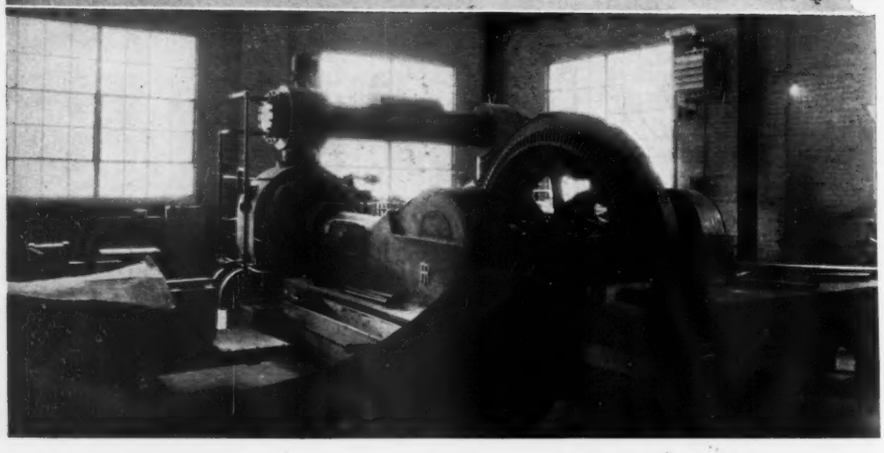
was to reach a suitable distance below the collar before the erection of the permanent steel headframe. To avoid damage to the concrete collar, only short holes were drilled and blasted a few at a time. The drilling round consisted of 91 holes; and, with a view to determining the most efficient drills for the work to follow, various types of machines were tried out. Rock was hoisted in a 1-cubic-yard bucket, dumped over an apron into small cars at the surface, and used to fill in and to level up the area adjacent to the shaft which was to serve for the storage of materials. Steel sets were placed in the shaft as sinking progressed, and had been installed to within 21 feet of the bottom of the 65-foot shaft when all work was suspended on November 24, 1930, to permit the steel erectors to construct the permanent headframe.

The headframe was erected under contract by the Lakeside Bridge & Steel Company, of Milwaukee, Wis., which firm carried out this work between November 25, 1930, and February 21, 1931. The structure is of steel, housed with corrugated iron. It is of the 4-post type with the top sheave wheels 132 feet above the collar. It contains space for the installation of a crusher at such a time in the future as furnace requirements may call for it. In October, 1931, an additional inclosure was built in front of the headframe to keep the snow away from the shaft and also to facilitate the lowering of steel, lath, and other materials in the shaft. It having been decided to use the existing Bonnie change house, 1,000 feet away, as a dressing room for the workmen, it was desirable to provide protection for them when coming off shift in wet clothing. Accordingly, a combination concrete tunnel and corrugated-iron walkway was constructed. The floor of the tunnel section left the shaft 8 feet below the collar; and the men were able to cover the

POWER HOUSE AND EQUIPMENT

A power house, having ground dimensions of 162x55 feet, and an adjacent heating plant were erected by private contract. These are permanent structures and house the electrical and mechanical equipment required in the conducting of the mining operations through the new shaft. At the right of the power house is a 52x65-foot cooling-water pond. Included in its equipment is a 50-hp. heating boiler with an automatic stoker. Provision was made for the placing of a second boiler later on. The two interior views show the air compressor and the permanent cage and temporary skip hoists during their installation.





entire distance between the shaft and the change house under shelter.

Meanwhile, Worden-Allen Company was constructing a steel-frame, brick power house and a heating plant to house equipment and machinery for use in the shaft-sinking operations and for the mining operations which were to follow. Foundations were poured for two compressors, one cage hoist, and one skip hoist, involving 1,077 cubic yards of concrete. A concrete basin for cooling water and two hold-down sheave foundations were also poured.

An Ingersoll-Rand Class PRE-2 compressor, having a piston displacement of 3,600 cfm. and driven by a direct-connected General Electric 700-hp. synchronous motor, was installed to supply air at 100 pounds pressure to the shaft and shops. An air filter was placed on the intake line and, to insure dry air for the tools, an I-R Class VM-4 aftercooler was interposed in the discharge line between the compressor and the receiver. A 6-inch air line was run to the shaft and shops. A second compressor of the same type and size will be provided to furnish additional air for the mining operations.

For raising and lowering the skips during shaft sinking there was installed an Allis-Chalmers double-drum hoist having drums 10 feet in diameter and 6 feet across the face. It was driven by a G-E 600-hp. induction motor through herringbone gears and had a maximum rope speed of 1,000 feet per minute. One drum was keyed, and a clutch on the second drum permitted operating one skip at a time. This hoist, with a drum capacity of 4,500 feet of 1⅜-inch rope, will be converted into a cage hoist when mining operations are started through the new shaft.

A temporary cage hoist was provided to serve during the shaft-sinking period. This was a Nordberg double-drum unit having drums 7 feet in diameter and 5 feet across the face. Like the skip hoist, one drum was keyed and the other connected through a clutch, thereby making it possible to operate either drum singly or both in unison. This hoist was driven by a G-E 400-hp. induction motor. It has a capacity of 2,700 feet of 1¼-inch rope and a maximum rope speed of 800 feet per minute. When mining operations begin through the shaft, this hoist will be put in service at the Woodbury Shaft and will be replaced with a large direct-connected skip hoist.

Power purchased from a public-service company was transmitted to the property at 33,000 volts and there transformed to 2,300 volts for driving the motors. A Westinghouse switchboard, with inclosed connections and switches and with visible meters and signal lights, was installed.

A temporary tool-sharpening shop was constructed adjacent to the headframe inclosure and equipped with two Gardener-Denver D.S.8 sharpeners and HP 20 punches for handling "Jackhamer" drill steel and with one Sullivan Class A sharpener for reconditioning the steel used for drilling the large central hole previously mentioned. Three oil furnaces, tempering tanks, racks for drill steel, and a work bench were provided; and an Ingersoll-Rand Type 4K shank grinder helped to reduce drilling costs by squaring up the shank ends of drill steels and the striking faces of drill pistons. A small adjoining structure was built to serve as a shop for making minor drill repairs. More extensive repairs were handled at the main shops.

A 10x20-foot wooden structure, located 200 feet from the shaft and heated with steam, was used for making up igniters into primers. It was kept locked when not occupied by a powderman. Powder was stored in a steel magazine about 100 feet away and 250 feet from the shaft. The former was insulated with 12 inches of sawdust retained by an exterior housing of wood, and this served to prevent freezing of the powder during cold weather. The magazine was fitted with a double lock to keep out all except those authorized to enter it. A small temporary structure was used for the storage of tools and equipment when they were not in service. It was heated with steam to prevent freezing of hoses and other items of equipment which might come from the job

THE MEN RESPONSIBLE

The shaft-sinking crew comprised 74 men working under the direction of a captain and four shift bosses. The miners did the drilling and the blasting and installed the steel.

with water in them. A steam-heated garage was built to house two G.M.C. 3- to 5-ton trucks which were employed for hauling rock excavated from the shaft. Cinder-surfaced roads were constructed to connect these several structures and the shaft.

Two 4-ton sinking skips of the chair type were built. Some details concerning them are given in connection with an accompanying illustration. Safety devices were provided to enable the skip to grip the guides in case the rope tension should be removed or diminished through any cause. Two sinking cages were also designed and constructed.

All these various and essential structures and items of equipment having been made ready, sinking of the shaft was resumed at the 65-foot elevation on April 30, 1931. An 8-inch flanged pipe line delivered compressed air in the shaft. This line extended to within 100 feet of the bottom, and a 4x4x8-inch tee was attached to its lower end. To each side of this tee there was connected a nipple and elbow, the two elbows having a span of about 4 feet. A length of 3-inch hose was then connected to each elbow and permanently connected to another 4-inch elbow which, in turn, was connected through a nipple to still another 4-inch elbow from which there extended downward a 4-inch pipe, 7 feet 3 inches long, which terminated in a header or manifold. The elbows and their connections were hung from the lowermost steel set by a 1-ton chain block; and, as the hose section was 25 feet long, it was possible merely by lowering the assembly as the shaft progressed in depth to serve several successive cuts before an extension of the main 8-inch pipe line was required. Details of the air-line assembly are shown in an accompanying drawing.

Each of the two headers or manifolds at the terminals of the delivery lines consisted of a 3x9-inch casting bored out in the center. Nine evenly spaced holes were then drilled around the casting and tapped for 1-inch connections. Seven 1-inch hose lines extended to rock drills, and each had interposed in it an I-R Type E line oiler. The two other lines served blowpipes, and each was fitted with a valve conveniently placed for operation by the miners when blowing holes. As two of these headers were used, it was possible to operate fourteen drills and four blowpipes simultaneously. When drilling of a cut was completed, the headers were disconnected, transported up the shaft by means of wire-rope slings underneath the cage, and hung at the shaft collar until they were again needed. They were then taken below by two men, detailed to that task, in order that drilling might be resumed as soon as mucking was finished.

For all except the center hole, Ingersoll-Rand X-59 "Jackhamers" were used. Each of these machines weighed 72 pounds, and to increase the drilling speed each was equipped with two removable weights aggregating 120 pounds. One-inch hollow, hexagon steel was utilized and made up in lengths up to 13 feet with 12-inch runs. Starting bits of both 4- and 6-point types were used. After holes were started, 4-point bits were employed. Starting bits were 2⅞ inches in diameter and decreased ⅛ inch in size with each change of steel, resulting in a 1½-inch bit with a 13-foot steel. Smaller-diameter holes were impractical for charging with powder. Much time was saved in placing holes in exact position by the use of spacers. Special tools were devised for recovering broken bits and for removing stuck steels.

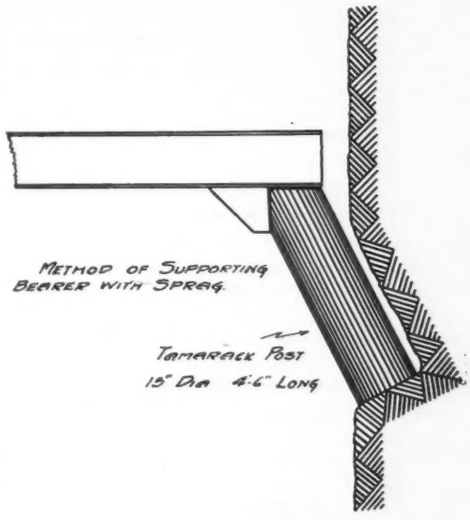
A Denver No. 17 drifter drill, equipped with handles, was used for the large center hole and was weighted with 73 pounds to increase its production. Hollow, round steel of 1½-inch section having 6-point starters 5⅜ inches in diameter and 4-point starters 5¼ inches in diameter were used with this machine. Allowing for a decrease of ⅛ inch with each change of steel, holes 13½ feet deep were bottomed with a diameter of 3⅞ inches. This center hole was started with the aid of a steel-plate guide having a central hole for the drill steel.

Several drilling rounds were tried out, variations being adopted with changes in the character of the rock. The best results were obtained with one providing for 68 holes. A plan of it is reproduced. The locations of the center hole and of the corners of the shaft area were determined by dropping plumb lines from the steel sets overhead. The miners then posted themselves for drilling so as to interfere with one another as little as possible. Three men were detailed to the center hole, which was designed merely to serve as an opening for the other holes to break to in blasting and which was carried a few inches deeper than the others. About two hours was required to drill this hole. A 12-inch length of 3-inch pipe was inserted in each of the smaller holes after it had been started so as to keep out rock fragments and sludge as drilling continued through it. Completed holes were closed with cedar plugs, pending their loading with powder.

To reduce congestion at the bottom of the shaft, sharp steels were supplied and dull steels removed at frequent intervals. These were transported up and down the shaft in a cage. In order not to interfere with the drilling, the cage was stopped 8 feet above the bottom and the steels were handed into and out of it at that point. Each drilling round required the use of about 800 pieces of steel, and the breakage per round ranged from 50 to 100 pieces.

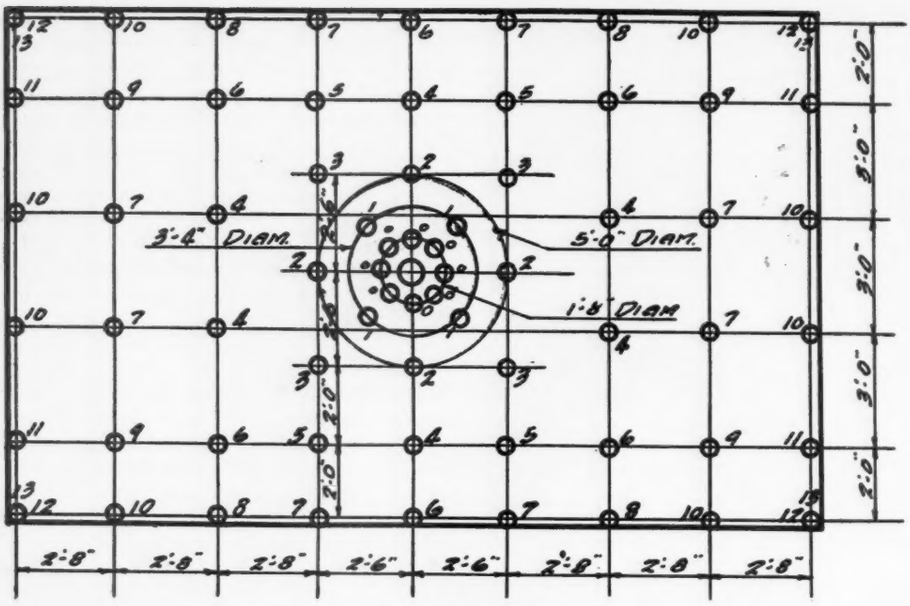
The 68-hole drilling round which was used most of the time called for the drilling of approximately 850 feet of hole. Holes averaged 12½ feet deep, and netted an average advance in depth of 10.83 feet for the 247 cuts which were made. The average drilling time was 9 hours and 32 minutes per round. Hitches for bearer sprags for supporting the steel sets were drilled during regular drilling shifts.

Water presented no problem, as the normal flow of about 4 gpm. was little more than that



BEARER SPRAG HITCH

Pending concreting of the shaft, bearing sets were supported by tamarack posts placed in hitches in the shaft walls. These hitches were drilled during the regular drilling shift. Each called for six holes 3½ feet deep. The lower two were horizontal, the central two were inclined upward 30 degrees, and the top two were inclined upward 45 degrees. They were fired with delays in the reverse order given.



PRINCIPAL DRILLING ROUND

Drill holes were arranged around a large central hole which provided an opening for them to break to. Of the several drilling rounds tried out, this one, providing for 68 holes which were fired with thirteen delays, proved most effective. Three men drilled the central hole with one machine, then put in Nos. 0, 1 and 2 holes. Meanwhile, other drillers were at work on the holes shown. All holes were vertical except Nos. 0 and 1, which were inclined very slightly towards the center. The average round required 850 linear feet of drill holes, and was completed in 9½ hours.

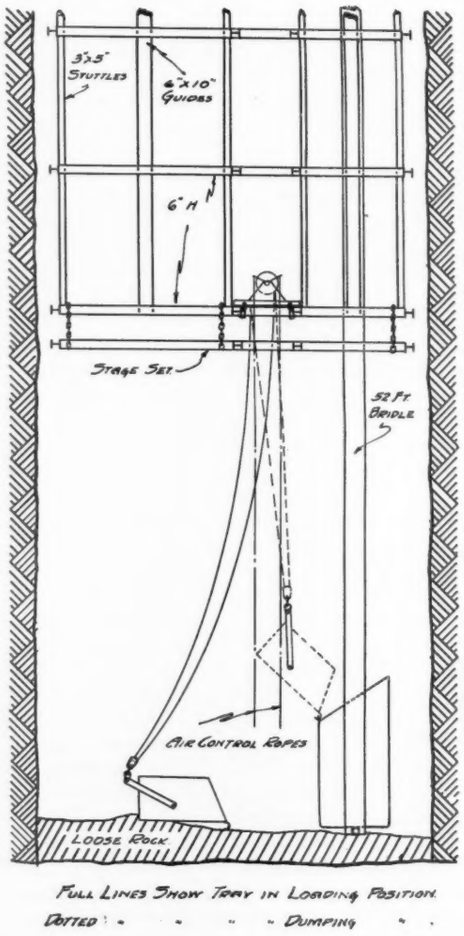
required for drilling. Excess water was pumped by a small C.P. Quimby centrifugal pump into a skip suspended about 15 feet from the bottom. When a skip had been filled it was hoisted to the surface and the water dumped into a launder, which carried it away from the shaft. A flow of water which entered the shaft through a fault plane at a depth of 215 feet below the collar was handled by cutting a small sump and installing a 50-gpm. Aldrich pump which was operated by a float switch.

Eighty per cent gelatin dynamite in 1¼x8-inch cartridges was used for blasting. No. 8 electric blasting caps and delay igniters were employed in accordance with the order of firing shown on the drilling-round plan. Primers were made up in the powder house; tagged with their respective numbers; and given an application of du Pont waterproofing material. Each was then inserted into a stick of powder whose outside paper covering was afterward tied tightly. All igniters were tested with a galvanometer to insure against misfires from faulty material. After it was made up, each primer was inserted into a strong cardboard guard, the inside of which was coated with glue. These guards were used as a precaution against premature blasts from sharp contacts. As a final operation, the igniter conducting wires were sandpapered to assure good connections.

Primers were divided into two groups as they were finished, and then placed in two wooden boxes, one to be used in each half of the shaft. Sticks of tamping were made of moist clay in 6-inch cartridges. Powder, primers, and tamping were sent to the bottom as needed, the powder being transported in canvas sacks. A double-throw, double-pole blasting switch, of which one throw short-circuited the blasting circuit, was stationed on the surface and was kept locked, with the shaft foreman in possession of the key. The power line was run down the shaft to within 200 feet of the bottom, where it, too, was short-circuited. It was wound on a reel which permitted pulling it out to any length required, and the ends were taken to the lowermost steel set and there twisted together until the final connection was made.

Following a round of drilling, all holes were blown out; all mechanical equipment was removed to the surface; the lights in the shaft were turned out from the surface; and the work of loading the holes was begun with the crew divided into groups under the supervision of the foreman. Four sticks of powder were placed in the bottom of each hole, except corner holes, and were followed by the primer. The remainder of the powder allotted to each hole was then inserted and the necessary tamping put on top of it. Tamping was done with a 1¼-inch round tamping stick. Powder charges varied for different holes. The zero-delay holes were loaded with eight sticks of powder followed by six sticks of tamping. In holes fired with delays, Nos. 1 to 11 inclusive, fourteen sticks of powder and three sticks of tamping were used. Corner holes were fired with two delays. Two sticks of powder were placed in the bottom of each and followed by a No. 13 delay. Eleven sticks of powder were then inserted, tamping was added to within 4 feet of the collar, and this was followed by a No. 12 delay, four sticks of powder, and tamping extending to the collar. This plan brought out the corners in a very satisfactory manner.

After all the holes had been loaded, the ends of the connecting wires were collected in groups. A double No. 20 lead wire was brought down from the steel sets overhead, laid in a circle around the shaft, and connected directly to the No. 0 delay holes, which were designed for instantaneous firing. One side of the connecting wires of each group of holes was then joined to the lead wire and taped. When all connections had been made on the first lead wire, the second one was brought down from the steel sets and the other connections made in a manner similar to the first. All tamping sticks, boxes, etc., were then loaded on a cage and hoisted with the crew to the bottom set of steel. There the foreman connected and taped the lead wires to the power line which had been dropped to that point. The cage was next hoisted to the power-line reel, where a



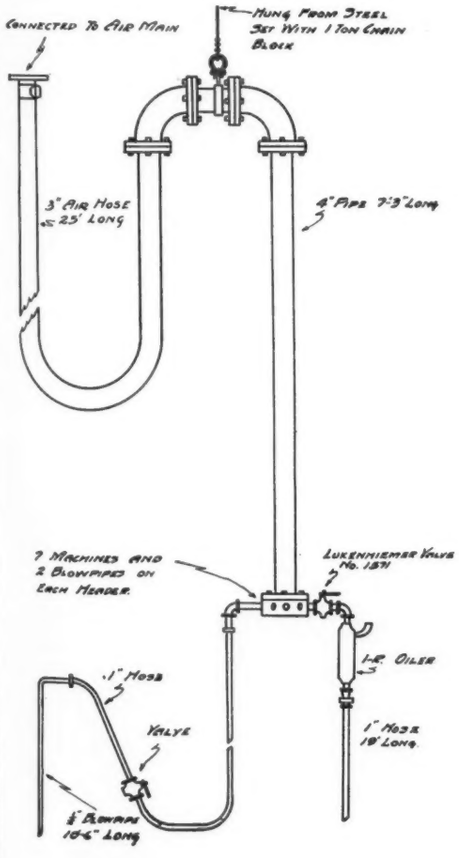
HOW MUCK WAS HANDLED

Broken material was shoveled into either of two trays which, when filled, were raised and dumped into a skip. A hook on the tray slipped over a bar on the skip, and further elevation inclined the tray for dumping. Trays were raised and lowered by two Ingersoll-Rand Type HU 10-hp., single-drum air hoists. These were mounted on 4-inch H-frames and secured to the steel in the pipe and ladder compartments overhead. This sketch also shows the manner in which bridles operated to allow cages and skips to be taken below the lowermost steel set, and illustrates the hanging of a stage or dummy set below the steel already in place to protect it against damage from blasts and to serve as a working platform when installing additional sets.

second connection was made. After the crew had reached the surface, the blasting switch was unlocked and the round fired. Following the blast, the switch was again short-circuited and the blasting box locked.

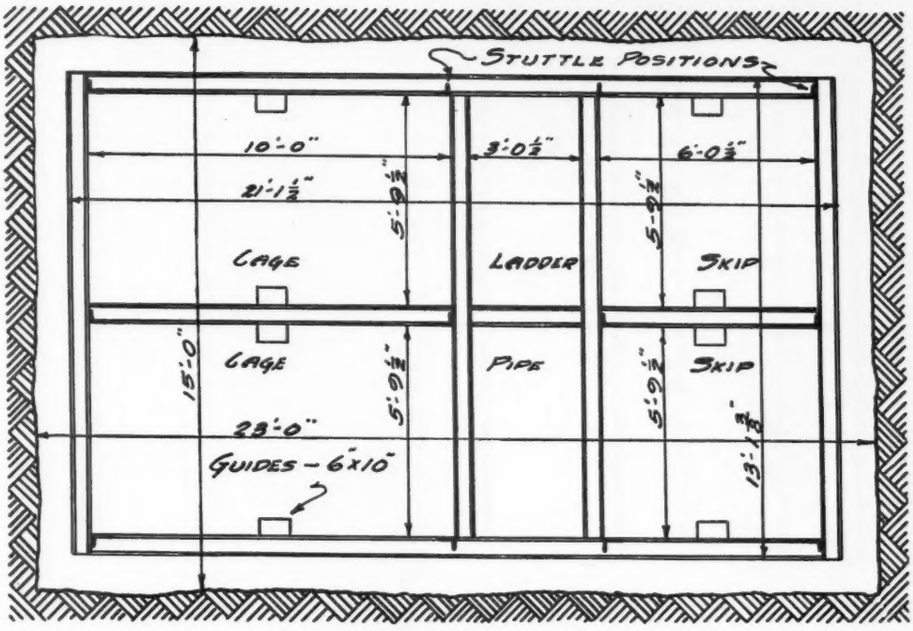
By means of a 15-hp. Coppus Vano blower, ventilating air was forced down the shaft through a 12-inch steel pipe to within 100 feet of the bottom and below that point through a vent tube which was pulled up just prior to blasting by means of a ½-inch hemp rope operated by a hand winch at the collar. Immediately after a blast the vent tube was lowered and the blower started. The outfit was capable of delivering 3,600 cfm. at the surface and 1,500 cfm. at a depth of 3,000 feet. Thirty minutes of blowing sufficed to purify the atmosphere sufficiently to allow the men to return to work. They descended slowly in both a cage and a skip, meanwhile inspecting the shaft and dislodging any loose rock which had been thrown up and was held in precarious positions on the steel sets. Below the level where steel had been installed the side walls were carefully examined and loose rock barred down. Preparations were then made to begin mucking.

The broken rock was shoveled into 35-cubic-foot steel mucking trays which were built like boxes but with the dumping end and the top open. These trays, of which two were used, were raised and lowered by means of a bail placed so that the center of gravity was towards the closed end of the tray to prevent it from tipping forward while being raised. While the trays were being filled, a skip was stationed at the safety mark in the lowermost steel set above.


Connected To Air Main
Hung From Steel Set With 1 Ton Chain Block
3" Air Hose ± 25' Long
4" Pipe 7'3" Long
7 Machines and 2 Blowpipes on Each Header
Lukenheimer Valve No. 1871
1" Hose
Valve
I-R Oiler
1" Hose 18' Long
¼" Blowpipe 18'6" Long

ARRANGEMENT OF AIR HEADER

Compressed air was carried down the shaft in an 8-inch line to within 100 feet of the bottom, where a valve and tee were installed. To provide air at the bottom, headers, such as the one illustrated, were connected at either side of the tee. These two headers supplied air for fourteen drills and four blowpipes.



CROSS SECTION OF SHAFT

The shaft is a duplicate of the Woodbury Shaft which has served for hoisting ore in the Newport Mine since 1916. It was sunk entirely in granite. It contains six compartments divided by steel members made up of 6-inch H-sets placed on 8-foot centers.

Skips and cages were constructed with bridles which enabled them to be lowered below the installed steel sets. These bridles consisted essentially of a vertical steel arm, on each side of the skip or cage which extended upward and engaged guides on the roadways above. The skip bridles were 50 feet long and the cage bridles 52 feet long. As the lowermost steel set was kept within from 35 to 50 feet of the bottom, it was possible at all times to land a skip or cage on the bottom. When one of the mucking trays had been filled, the skip was rung down to the bottom and the tray raised and dumped into it, after which the skip was hoisted to a position about 15 feet above the bottom until the second tray was ready for dumping. The skip had a capacity of about 75 cubic feet, or two trayloads, and upon being filled it was sent to the surface. The mucking trays were handled by means of two Ingersoll-Rand Type HU single-drum air hoists of 10-hp. capacity. Their method of mounting and control is explained in connection with an accompanying illustration.

As mucking proceeded, the side walls were continually trimmed of loose material. After some of the bottom rock had been shattered, one of the air headers was lowered and connected. Four Ingersoll-Rand L-54 paving breakers fitted with spades and diggers were then used to work it loose. During this cleaning-up period one tray sufficed, and the work necessarily proceeded at a slackened pace. Mucking continued until a firm bottom was reached. An average of approximately 250 cubic yards of rock was removed from each cut, and the average time required was 23 hours, 5 minutes. The small volume of water encountered during the mucking was pumped into the skips and hoisted with the loose rock to the surface.

About 30 minutes prior to the completion of mucking, two men were sent to get the second air header and the drilling equipment. The cage which brought them down took back the mucking equipment, thereby immediately clearing the space and enabling drilling to be started without delay. When the ascending cage reached the level where the hoists were stationed, these also were loaded aboard and taken to the surface.

Steel sets were installed after each blast unless it meant a distance between the lowermost set and the bottom of less than 35 feet, as it was found that considerable damage resulted from blasting when the steel was carried too low. The maximum distance to which steel could be carried above the bottom was governed by the bridles on the skips and cages, namely 50 feet. When necessary steel was placed immediately after blasting, although it was preferably left for the morning shift. A stage or dummy set of steel was hung by chains 2 feet below the lowermost regular set of steel to serve as a buffer in blasting. This set was a regular shaft set with double dividers strapped together and with tamarack timbers tied to the underside between the flanges of the members. This stage set took the brunt of the blows from the blasts, and very few replacements of shaft steel had to be made. Whenever the stage set became so badly bent or twisted as to impair its usefulness, it was cut into pieces with a torch for removal to the surface and a new set substituted.

The first step when installing steel was to lower the stage set 10 feet below the lowermost permanent set by means of four 1-ton chain blocks hooked on to the second lowest set. A plank platform was then placed on the stage set, and the hanging of wall plates was started. All steel members were carried down the shaft in the cages or suspended underneath them. After the two wall plates had been hung on studdles, the end plates and dividers were installed and the set was lined and blocked. The lining was done with the aid of 1-pound weights suspended from diagonal corners of a plumbed set above, the suspension wires being held by a template set over the flanges of the wall plate and the end plate at a point 6 inches from both inside faces of these members. Blocks, which had been cut into prescribed lengths on the surface, were placed at both ends of the dividers, wall plates, and end plates and made tight with pine wedges. Hardwood lath, 2 inches thick and 6 and 8 inches wide, was cut into lengths just short of the 8 feet that divided the steel sets, and these were then inserted vertically in the flanges of the wall and end plates. They were made tight by wedging 2¾-inch filler pieces between the inside flange of the steel and the lath. Two sets of steel were placed and lathed during one installation period. Guides for the skips and cages, made up of 6x10-inch dressed yellow pine 85 per cent hearts, were framed to span two sets of steel and were secured with ¾x7-inch bolts. After the sets were in position, a length of air pipe was lowered underneath the cage and bolted in place.

Bearing sets were installed at intervals of about 150 feet. The bearers were of 12-inch I-beams which were spaced by 10-inch channel iron. In the course of construction these bearers were strapped to the shaft set with ¾-inch straps. The channels were then put in position and 15-inch tamarack sprags used to support a set until such a time as concrete could replace them. To insure a bearing set being level, it was customary to level up a shaft set a short distance above the elevation at which the bearers were to be installed. Iron ladders were provided in lengths of two sets; and protective collars, of electroforged-steel grating and made up in two pieces, were put in place.

No regular steel crew was maintained, and all shaft construction work was done by the regular force of miners, who also handled the successive operations of drilling, placing powder, and mucking. All told, the organization consisted of 79 men, of whom 52 were miners. The remainder of the personnel was as follows: one captain, four shift bosses, two construction men, one electrician, one pipeman, three landers, three truck drivers, six hoisting engineers, five shopmen, and one powderman. Work was carried on 24 hours a day and seven days a week. The miners and shift bosses worked four 6-hour shifts, one shift boss and thirteen miners to a shift. An 8-hour shift applied to all other labor except shopmen, who worked one 10-hour shift only.

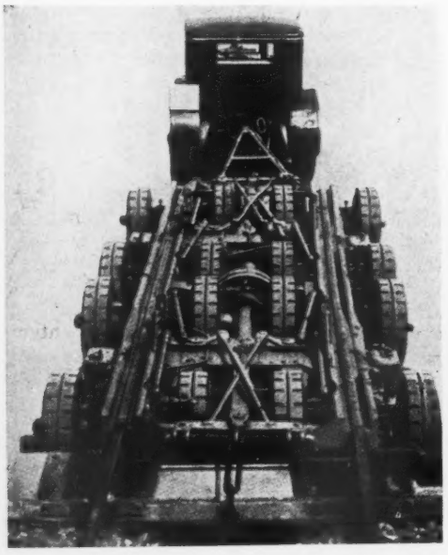
All bell, power, and light lines were in the ladder road. Light was supplied at the bottom by an electric fixture suspended about 15 feet above the working level and having cellophane over the globe guards to protect the globes from being broken by material blown from the drill holes. Sigaphones on both cages made it possible for them to be stopped or started at any point in the shaft. An induced-current telephone was the means of communication between the cages and the collar or power house. Steel and other equipment were ordered from the bottom by means of an electric-bell signal system. Air and lights were turned on and off in a similar manner.

The utmost care was taken to safeguard the workers from injury. No person was allowed to enter the shaft unless he wore a hard hat, and strict enforcement of this rule reduced the number of head injuries to a minimum. Descending skips and cages stopped at the safety mark at the lowermost set of steel, and were moved lower only upon signal from the bottom of the shaft. Safety chains attached air hoses to rock drills to prevent the hoses from whipping in case they became detached.

The work was in charge of Capt. Henry Eplett, and to him, because of his untiring efforts and enthusiasm, must go much of the credit for the successful completion of the undertaking.

RAILWAY DELIVERS FREIGHT FROM DOOR TO DOOR

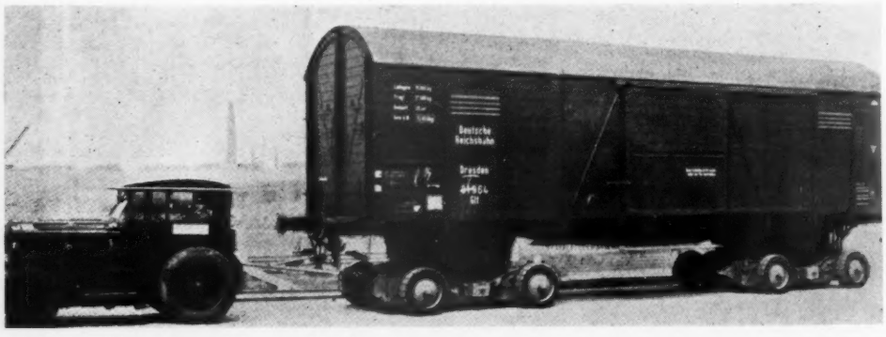
DOOR-TO-DOOR transportation of bulk freight, regardless of whether or not the shipper or consignee is located on a siding, is a problem that the railroads have been trying to solve in one way or another and with more or less success for a number of years. An answer to it seems to have been found by the German State Railway, which has developed a highway truck that tests have proved to be commercially practicable. It is designed to bring an empty to your factory on request; to transfer it loaded to the rails; and, at the other end of the line, to haul it to its destination.

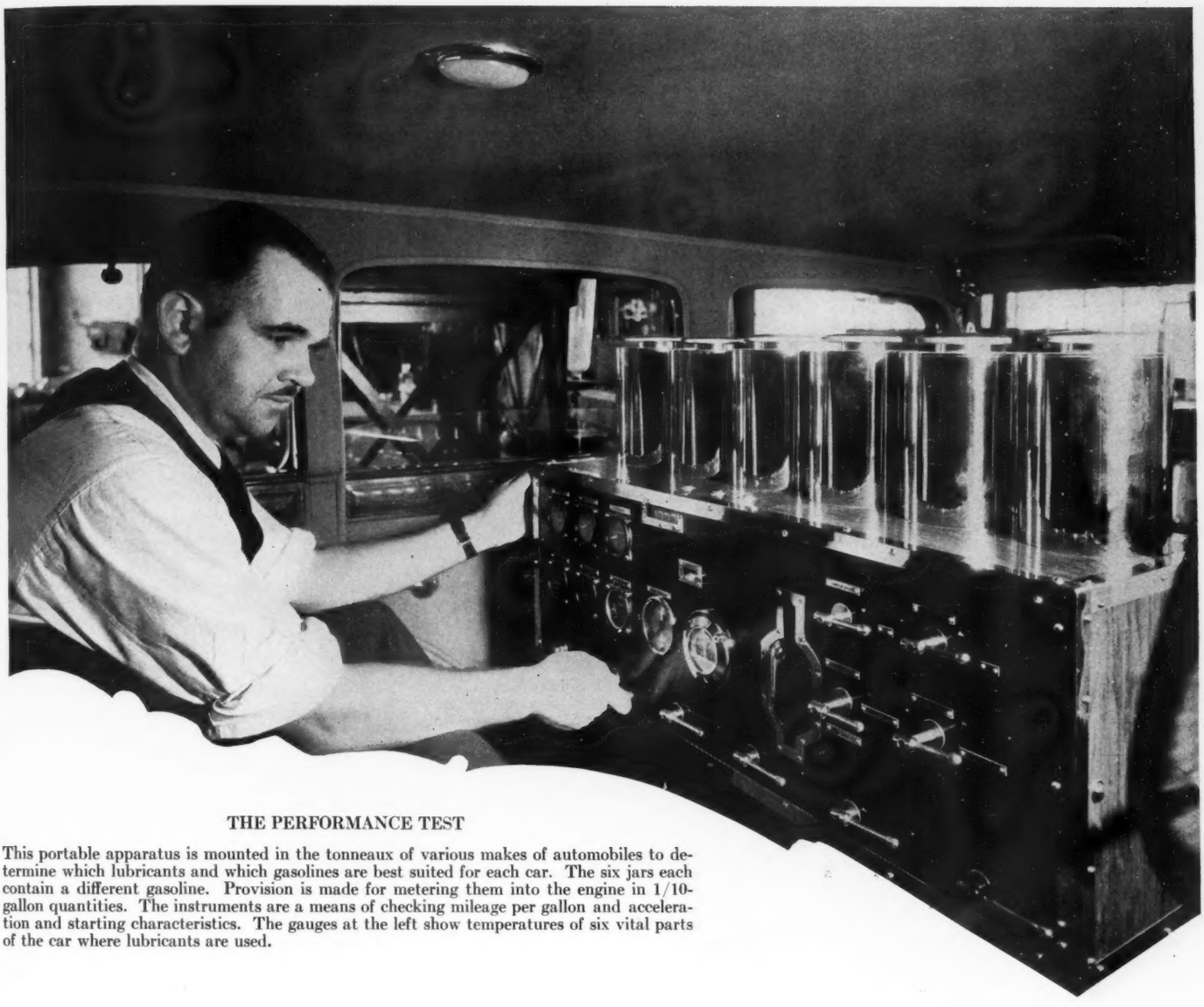


The vehicle that makes this possible is the work of H. Culemeyer, and consists of two trucks each of which has eight rubber-tired wheels. These are disposed of in pairs, two to a side, and between them rails are run lengthwise. The arrangement is such that every wheel is under the control of the steering gear, something that is of the utmost importance in transporting loads of great size and weight through city streets. The combined weight of the trucks is 20 tons which, together with the regulation 20-ton car they are designed to carry, represents a burden of 2.5 tons on each wheel—a load distribution that is considered adequate for street traffic. By means of extension couplings the units can be connected so that the gap between them can be shortened or widened to suit requirements. A small tractor serves to draw the truck.

When transferring a car from the rails, the truck units are brought close together so as to form a continuous track and are backed up against an elevated siding that is of such a height that its rails are in alignment with those on the truck. When the car has been shifted far enough so that a pair of its wheels rests upon the outer truck unit, the latter is pulled forward by the tractor until the whole underbody is properly adjusted in relation to the car, after which the couplings are made. The rail sections on which the car wheels stand are then lowered by hydraulic jacks to form V-shaped cradles and, at the same time, to drop the axle ends into suitable anchorages. These operations are reversed when it is desired to put the car back on the siding.

Reports have it that the new carriers are meeting all the expectations of the German State Railway, which is planning to put them to use in various industrial areas. As has been aptly expressed, it really means bringing a private siding to the door of every factory, thus obviating the rehandling of goods in transit and making for greater dispatch.





THE PERFORMANCE TEST

This portable apparatus is mounted in the tonneaux of various makes of automobiles to determine which lubricants and which gasolines are best suited for each car. The six jars each contain a different gasoline. Provision is made for metering them into the engine in 1/10-gallon quantities. The instruments are a means of checking mileage per gallon and acceleration and starting characteristics. The gauges at the left show temperatures of six vital parts of the car where lubricants are used.

Saving and Using the Lighter Gases in Gasoline

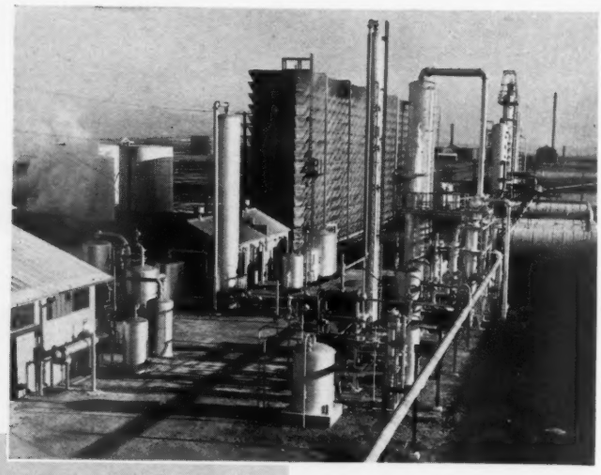
LAWRENCE A. LUTHER

IT IS one thing to have weathered the past four subnormal years in the history of American industry, and another to have carried on according to the traditions of the late "twenties"—that era of rapid change when even the comparatively new was discarded if something better had been found to take its place. Outstanding among the latter group is the petroleum refinery industry. It is perhaps not overstating the case to say that nearly every major refinery that was rated as modern as recently as 1929 would today be considered incomplete or obsolete provided no improvements had been made in the meantime. In other words, during the intervening years, there has been an unremitting quest for more effective and economical processes by which to extract higher percentages and better grades of fuels and lubricants from each barrel of crude treated.

Though few of us pause to appreciate the marked advance which has been made in the utilization of our national petroleum resources, we sense quickly via our pocketbooks any savings or improvements in performance resulting from the final products. Using the Associated Oil Company refinery at Avon, Calif., as a typical example, we shall attempt to outline a few of the methods, based on research and experience, which swell the margin of profit for refiners and pass on dividends to the motoring public.

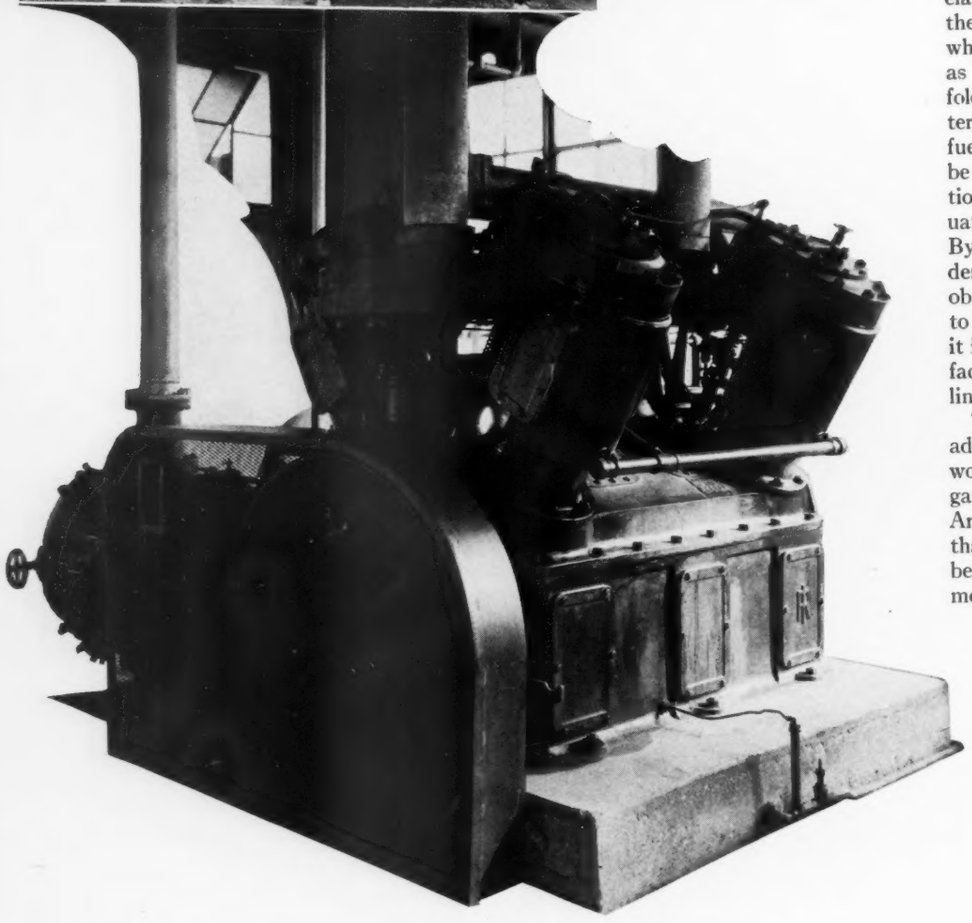
This large Pacific Coast refinery occupies a 3-mile stretch of tideland on Suisun Bay some 35 miles from San Francisco. Pipe lines, converging on Kettleman Hills and on groups of wells that penetrate great oil pools in the southern and coastal areas of the state, bring in the essential raw petroleum. The domestic territory served with fuels, a complete line of lubricants, and various by-products, includes the states of California, Oregon, Washington, Idaho, and Utah; and a fleet of tankers and regular cargo vessels supply Alaska, the Hawaiian Islands, and a considerable trade in the Orient. Some 750 employees are required to operate this 1,270-acre plant and to take care of its allied activities; and a permanent village, with its own post office, is a part of the institution.

Most of us know that motor manufacturers have adopted higher compression ratios more or less rapidly—65 per cent of American cars having altered radically in this respect since 1928. But we are prone to forget that the design is really attributable to refiners who developed fuels that made this change feasible. Not only that, but to them must go the credit for increased fuel economies which, in terms of ground covered, amount to from one



REFINERY ABSORPTION SYSTEM

Large portions of the more volatile constituents of petroleum that have a tendency to escape during the refining process and storage of the products are salvaged by compressing them and absorbing them with suitable oils. These views show the absorption system at the Avon refinery (above) and the compressor house (left.)



to three miles per gallon, as well as for much of the marked improvement in performance even in the cheaper makes of cars.

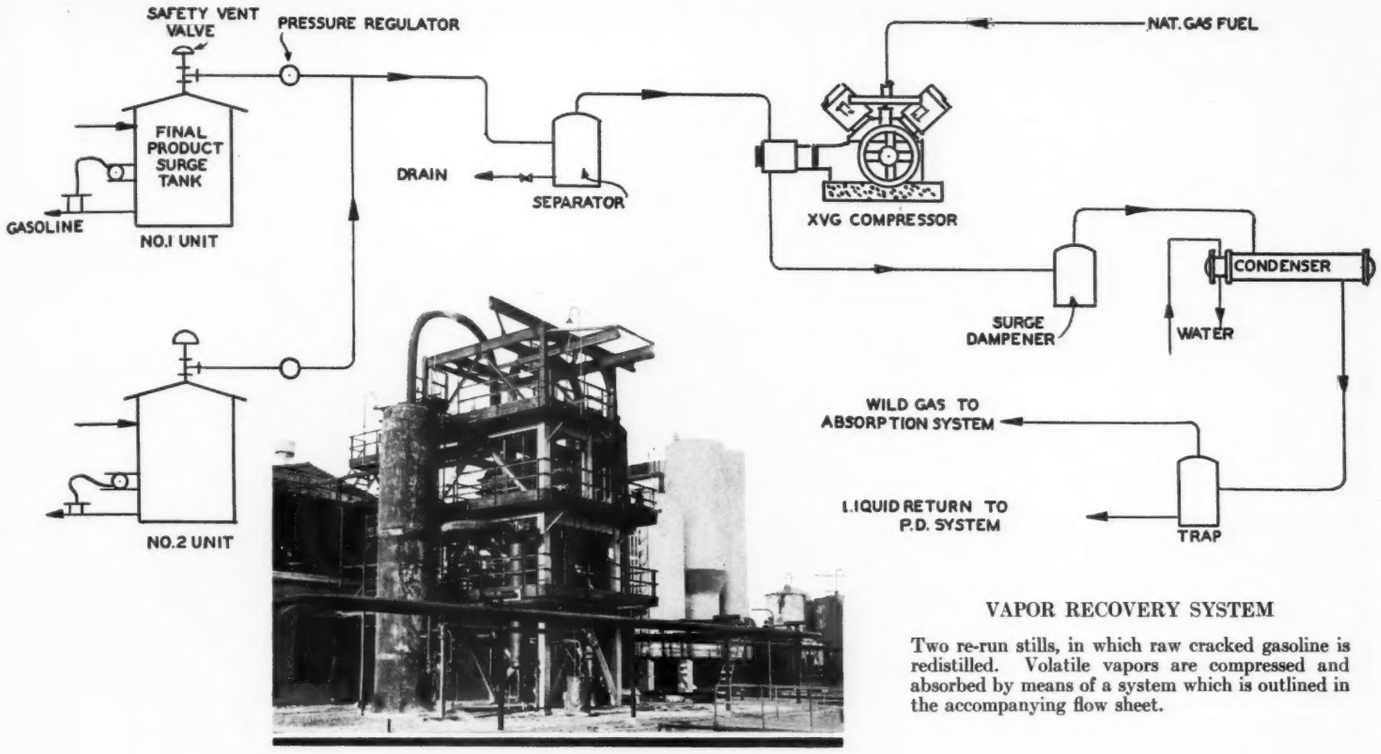
Only in recent years have season and latitude entered into the blending of wide varieties of distillates produced by large tube-and-tank-type cracking units such as are employed in the Associated Oil Company refinery. But now, motor fuels of climatically correct volatility are guaranteed the year round to suit the needs of far-flung regions no matter whether they are located in the tropics or near the Arctic Circle. Each twelvemonth, this refinery makes a total of sixteen changes in its gasolines, basing them on information furnished by as many as 470 weather-bureau stations. The weather charts so obtained are supplemented by many mechanical devices in the laboratory. For example, a test motor connected with a dynamometer determines the horsepower content of any fuel, while a knock meter registers knocks inaudible to the ear. This meter is connected with an octane-testing machine which is essentially a motor in which the compression ratio may be altered through a wide range.

For some time it has been the practice of the more progressive oil companies thus to analyze the fuel and lubrication requirements of each popular American car as soon as it was released. The Associated Oil Company, however, has recently gone a step farther in order to amplify and to check the information to be placed in the hands of its service organization: it is equipping cars of various makes with an elaborate testing apparatus. This is set up in the tonneau. It has six sensitive indicators which register the temperatures of such parts as transmission, crankcase, and intake manifold; and the contents of six jars may be metered precisely, while the mileage per gallon of fuel, acceleration, and starting qualities can be recorded under widely diversified conditions by a special speedometer that is graduated to register one-thousandth of a mile. By operating these laboratories on wheels under climatic conditions ranging from those obtaining in the high altitudes of the Sierra to the below-sea-level heat of Death Valley, it is possible to bring to light many significant facts concerning oils and greases and gasolines.

There seems to be no doubt that strict adherence to the comprehensive specifications worked out in this way would, in the aggregate, save many millions of dollars annually. Among other things, it has been established that there is a difference of six miles per gallon between the maximum fuel economy at the most efficient motor and lubricant temperatures and the cold-motor extreme of wastefulness, and that from one to three miles per gallon are quite commonly sacrificed in winter driving

WHERE GAS COMPRESSES GAS

Natural gas serves as fuel for operating this Type XVG compressor which handles vapors from two gasoline redistillation units. Power cylinders are assembled above the crankcase, and compression cylinders are horizontal. This unit has a piston displacement of 730 cfm.



VAPOR RECOVERY SYSTEM

Two re-run stills, in which raw cracked gasoline is redistilled. Volatile vapors are compressed and absorbed by means of a system which is outlined in the accompanying flow sheet.

through the use of improper lubricants.

The various elements which give gasoline its desired characteristics of easy starting and ready responsiveness to the throttle are the more volatile components of the crude petroleum; and the methods now employed to prevent their escape as light gases in the process of refining and during storage represent the cumulative experience of years. Most of us know something about the vapor pressures developed in a can or drum of gasoline under ordinary atmospheric conditions, and can perhaps comprehend the magnitude of the annual aggregate loss that was incurred when these valuable constituents escaped from millions of gallons of fuel stored in tanks. Modern practice obviates this through the use of a system that automatically gathers up these wayward vapors and then salvages their desirable components by means of compression and absorption, thus producing a homogeneous, stabilized fuel

At the Avon plant of the Associated Oil Company, pipe lines—connected by automatic valves that maintain a vacuum of about ½ inch of water—collect the gases from all run-down tanks, collection tanks at stills, and process and storage tanks, and deliver them to a centrally located compressor house. The compressors operate at 30 and 35 pounds pressure, and discharge into bubble-cap towers. These are essentially tanks some 40 feet high carrying horizontal pans having a series of apertures covered with caps. Absorbent oil is pumped through these pans and stands at a level that permits the gases to bubble out and around the submerged edges of the caps—their absorption being effected gradually as the vapors rise through the successive pans. Nonabsorbable or "wild" gases are discharged from the tops of the towers and are utilized to refill the vapor spaces in storage and gauging tanks when lowered temperatures cause them to "breathe in" or when the liquid contents are removed. By confining all vapors arising in tanks and by preventing air from entering them, there has been eliminated one of the most fruitful sources of fire, the dreaded menace of refineries.

So-called fat oils, which are saturated with compressed gases, are pumped to stills that are similar in general construction to the bubble-cap absorption towers described and operate at a temperature of 275°F. or, with the addition of a small quantity of stripping steam, at 325°. Discharged vapors are condensed in water-cooled tubular condensers and, before storing, are processed in a stabilizer that operates at 175 pounds pressure and at top and bottom temperatures of 250° and 120°, respectively. This serves to eliminate propane and other unstable gases.

A somewhat more recent addition to the plant consists of a vapor-recovery unit drawing vapor from a collecting tank serving two re-run units which effect a redistillation of the raw cracked gasoline. Each comprises two separate stills—one operating at atmospheric pressure and the other being of the high-vacuum type with a maximum vacuum amounting to 27 inches. Vapors are drawn from the common discharge tank through a 6-inch line, and access from tank to line is controlled by an automatic regulating valve while a compressor maintains a line vacuum ranging from 12 to 18 inches.

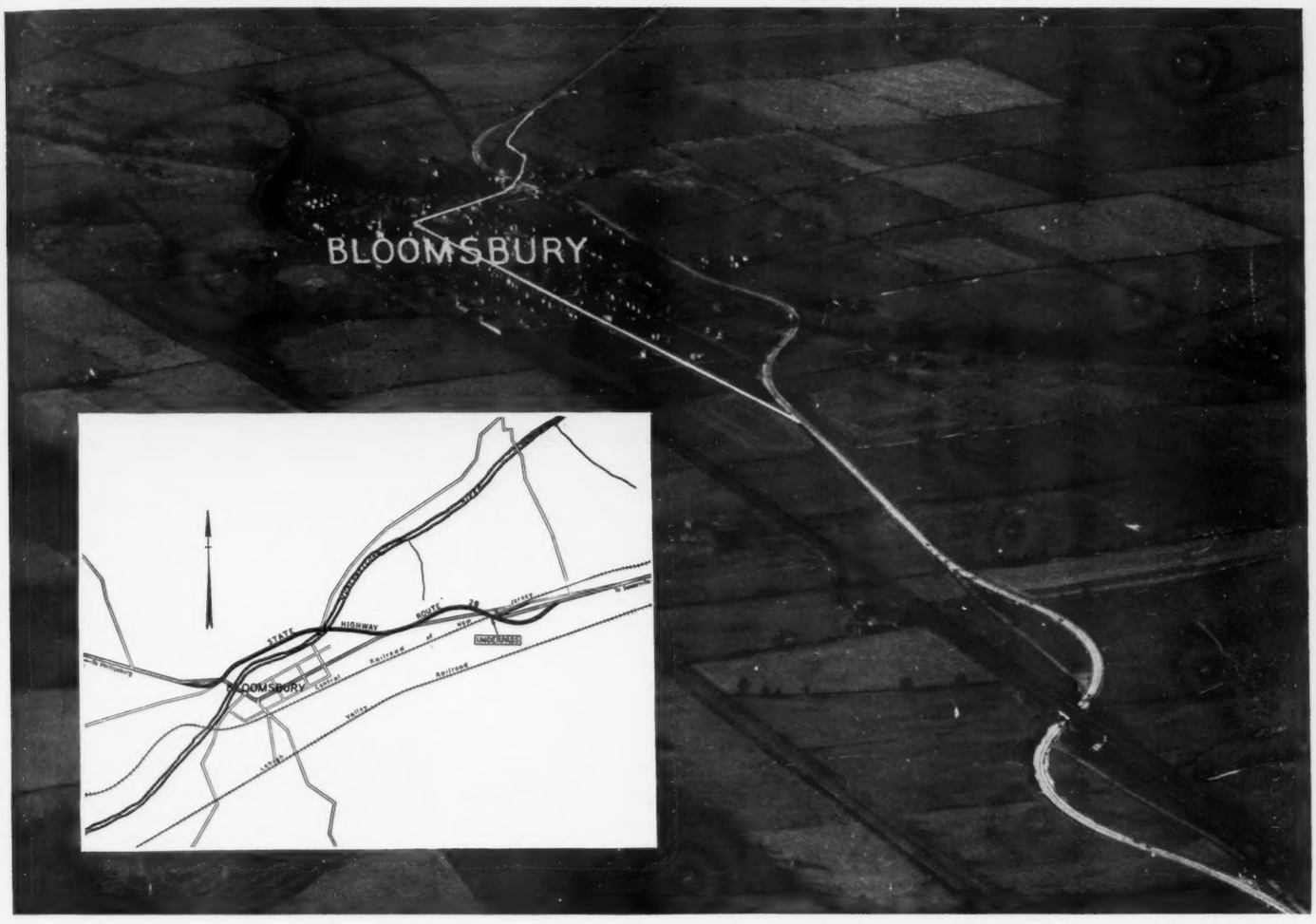
Though steam- and electrically driven compressors long have had varied application in refinery processing, the generally prevailing abundance and cheapness of suitable fuel gases have recently created a vogue for gas-engine-driven machines. A 2-stage, 15&9¼x12 XVG unit, burning natural gas piped from the Kettleman Hills field, was selected for installation at Avon, while a similar machine of the XG type was made a part of the recovery system in the Associated Oil Company refinery at Watsonville, Calif. In the Avon hook-up described, the vapor delivery from the stills to the collecting tank is erratic, and for that reason unusual flexibility of control is required of the compressor. This is achieved either by manual or by automatically operated 5-step clearance control consisting of clearance pockets that serve the compressor valves.

Occupying but 120 square feet of floor space, the unit is of strikingly compact design. The power cylinders are assembled at an angle of 60° in two banks of two cylinders each on a main frame carrying the common crankshaft through which drive is effected. The compression cylinders are horizontal. The machine has a displacement of 730 cfm. at 300 rpm. High-tension magnetos provide ignition, and 200-pound air is used for starting. Richness and other characteristics of the gas suggested dispensing with intercooling between stages; and, with no objectionable temperature rise developing, lessening of the amount of condensate delivered to the high-pressure cylinder has simplified its lubrication. Intake gas is carried through a liquid separator before it goes to the compressor, whence it passes first to a surge dampener and then to a Braun tubular condenser drawing water from a ventilating-louver cooling tower used in conjunction with the absorption-system condensers. This condenser delivers to a trap provided with an automatic, float-operated valve maintaining a constant liquid level. The condensate is returned to the discharge from the re-run units while the vapors go to the absorption system previously described.

(C) Abrams Aerial Survey Corp.

VERTICAL AERIAL PHOTOGRAPHS

These are contact prints and, to make an aerial map of an extensive area, large numbers of them are assembled in the form of a mosaic. The larger picture, showing a portion of Lansing, Mich., is to a scale of 1 inch = 400 feet. The smaller is to a scale of 1 inch = 800 feet, but satisfactory enlargements can be made from the negative. It will be noted in the larger view that vertical walls of buildings are not visible in the central portion, but are increasingly apparent towards the edges as lines sloping away from the center. This property of optics is made use of to reveal the third dimension by examining two overlapping prints in a magnifying stereoscope.



New Jersey Highway Commission

PHOTOGRAPH VERSUS DRAWING

Oblique aerial photograph and sketch of Bloomsbury, N. J., indicating changes which were made in State Road 28 to by-pass the town and to eliminate right-angle turns at a railroad underpass. Because of distortion, oblique photographs are of little value in map making, but they are useful in reconnaissance and for showing work done.

Engineering from the Sky

C. H. VIVIAN

RELATIVELY few persons know how extensively aviation aids engineering work of various kinds. Probably not even the most ardent advocates of aeronautics foresaw during the pioneering period that this new mode of transportation was to become of great practical value for such purposes. Undoubtedly they visioned its helpfulness to the explorer; but little did they dream that its benefits would reach to the more detailed field of engineering planning and investigation. Yet, with aviation scarcely 30 years old, it is fast becoming one of the working tools of the geologist, the highway engineer, the city planner, the topographic mapper, and numerous other members of the technical professions.

Beyond question, the best vantage point for viewing any area of the earth's surface is directly overhead. The range of vision is at a maximum from the air, and things that are difficult or impossible to see from the ground show up clearly. Furthermore, every object or physical feature is seen in relationship to its surroundings. By flying over a stretch of ground, even the untrained observer can often gain a better idea of it in a few minutes than could be obtained in days of surface travel.

The particular value of aviation to engineering lies in aerial photography. Revealing as visual observation is from aloft, the eye can, at best, get only a general impression of the country flown over, and, even when repeated flights are made, many details inevitably escape attention. The camera lens, on the other hand, not only sees everything within its field of focus but retains the image in the form of a permanent record which may be studied at leisure.

Figuratively speaking, photographs secured in this way enable the engineer to stop the plane over any section as long as he wishes while he makes a detailed examination of the territory beneath him. If he desires a closer view of a particular area, he need only call for an enlarged print. Two, three, or a hundred persons, if need be, may consult the photographs, and the camera thus becomes the collective eye of all of them. In short, aerial photography affords a means by which engineers can make surveys without leaving their offices.

As a matter of fact, the men who make use of the photographs seldom take them—that detail being left to specialists. The engineer works entirely from the prints; and, under the scrutiny of an expert, a set of aerial views yields all the essential information for the making of an accurate map of the territory pictured.

The scope of aerial surveying is world wide. It has been resorted to in laying out railroads in Persia and Argentina, in detecting sand bars and rapids in the Zambezi River in South Africa, in recharting the coast line of New Jersey, in planning civic improvements in

New Jersey Highway Commission

WHERE FOUR ROADS MEET

Traffic circle near central airport, Camden, N. J., as seen from the air While it was not made for the purpose, this view illustrates the advantage of aerial photography in taking traffic counts. It shows the actual number of cars using the highways—something that cannot be ascertained by checking traffic as it passes a fixed point.

Johannesburg and New York City, in laying out irrigation districts in Iraq and the Transvaal, in making forestation and vegetation studies in Canada and Burma, in conducting soil and erosional researches in England and northern Rhodesia, in determining likely areas for mineral prospecting in the Arctic Circle and on the South African Rand, in making coast and geodetic surveys in California, and in threading roads among the sand dunes on the shores of Lake Michigan. The list might be indefinitely extended. Each of these various uses touches the field of a distinct branch of engineering, all of which are coming to rely more and more upon the assistance of aerial photography.

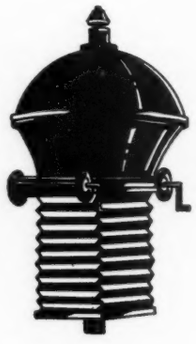
Speaking recently before the South African Institution of Engineers, Capt. C. R. Robbins, of The Aircraft Operating Company of Africa, Ltd., predicted that "it will be but a short time until no reputable company will attempt any development scheme, whether railway, mines, land, irrigation, etc., without first having a thorough initial review of the whole situation made by aerial survey."

The photographic record of such an aerial survey will frequently serve a variety of purposes. In the case of a South African mining company, for instance, the survey may be made primarily to aid geologists in working out structural conditions favorable to prospecting for additional ore bodies. Once made, however, it can be used thenceforth for locating highways, railroads, power lines, hydro-electric developments, and extensions of surface plants. It often happens that company executives who must pass upon expenditures for these works have their offices in London and visit the properties only periodically. In these and similar cases, much time may be saved in obtaining decisions merely by marking the proposed structures on a composite aerial photograph and forwarding it to those in authority for their inspection and approval. Such a composite view can be made up more quickly and at a lower cost than a conventional topographic map, and, besides, is much more accurate and easier to understand.

The art of gaining useful engineering information from aerial pictures has progressed so far that surprising and almost unbelievable results are now obtained This is attributable in part to the previously noted fact that the camera faithfully records things that are not visible to an observer on the ground and that frequently elude the eye even in flights over the area concerned. Of equal importance is the technique that has been developed for putting the photographs to use. Although they show much at a glance. the views require careful and intelligent study and handling to bring out all the information contained in them. Even to the trained technician, parts of their story are obscure and must be pieced together by patient examination and logical interpretation. A line on a photograph that the layman would dismiss as a blemish in the paper may turn out to be the surface indication of some buried geological manifestation. Underground faults which are not disclosed even by an examination of the ground surface will frequently show up on photographs. Similarly, igneous intrusions such as dikes which do not outcrop are sometimes clearly revealed by the camera record. The ecologist finds aerial photography of material aid to him because differentiations in the characters of soils are evidenced on the prints by variations in color intensity. Also, demarcations in the types of vegetation, signifying changes in soils, stand out boldly.

It goes without saying that the amount of information that can be gained from aerial photographs varies with the skill, experience, and intelligence of the interpreter. Considerable knowledge of the natural sciences is essential to efficient work of this type. The observer must also have imagination properly attuned to his scientific attitude. He should be able to set up the various hypotheses which are suggested by the photographic evidence and then, by testing each of his assumptions in the light of his scientific knowledge, to determine which of them is most likely correct.

Although it had been previously practiced in a limited way, aerial surveying received its real impetus during the World War. All the armies engaged in that conflict became uncannily adept at detecting what the enemy was doing or planning to do. This important work was handled by the intelligence corps of the several belligerents. When the war ended, these specialized methods and trained personnels were available for the service of applying aerial photography to peacetime purposes—the war having advanced this science to a point which, under ordinary circumstances, would not have been reached for years.



Abrams Aerial Survey Corp.

DISTORTION CORRECTOR

This instrument, invented by Talbert Abrams, president of a commercial aerial survey company of Lansing, Mich., permits making a print to any desired scale from the original negative and to correct distortion. Sensitized paper is placed in the bowl-like recess which is curved to counteract the distortion arising from the curved lenses of the camera and the projector. Errors arising from tilt of the camera, plane, or ground are eliminated by tilting the base, in which the paper rests, an equal amount in the opposite direction.

Finding that aerial reconnaissance and photography were invaluable aids on the battlefield, the war departments of the various nations retained them in their training programs, and they still form an important part in the schooling of military fliers. For several years following the armistice, most of the industrial aerial photography was done by former army fliers, as they were about the only ones suitably trained and equipped for it. Gradually, however, private enterprise entered the field, and in all the leading countries there are now competent commercial organizations engaged in the work.

One reason why the army observers became so expert in interpreting photographs was that enemy camouflaging operations forced them to utilize every mental resource at their command in deciphering the messages imprinted on the sensitized films. As both sides were employing this method of surveillance, all the contending forces quickly learned from the pictures they made that certain activities left telltale evidences on the ground, and they immediately took measures to shield corresponding operations of their own from enemy eyes and lenses. Thus there developed a thrilling game of hide and seek in which all the players profited by the mistakes of their adversaries and made it progressively harder for useful information to be secured from aloft.

Early in the war the intelligence corps learned to tell the shapes of ground structures and to estimate accurately their sizes by the shadows they cast. They were also quick to find out that movements of marching troops, even though they were conducted under the cover of darkness, wrote themselves on the landscape in the form of paths which showed up clearly on photographs. Even a telephone or power line could be identified as a series of dots joined by lines. The poles and wires did not register: what the camera caught were the mounds of freshly excavated earth at the bases of the poles and the path connecting them that had been made by the workmen who strung the line.

In a similar manner the building of highways and railroads was revealed. By the time the conflict entered its fourth year this science of interpreting aerial photographs had become so exact that it was virtually impossible for either side to hide from the other evidence of movements of magnitude. The German offensive of July 15, 1918, in the Champagne District was anticipated by the commander and staff of the French second army through the disclosures of cameras flying thousands of feet overhead out of range of anti-aircraft guns. The concentrations of men and supplies were plainly shown by railroad sidings and detraining points, airdromes and landing fields in course of construction, and by the gradual daily increase in hospital trains and other rolling stock. As a result of this advance knowledge they were able to bring up men and materiel to meet the attack. It is probable that the German intelligence corps, in turn, secured photographic evidence of these counteractive efforts. In addition to obtaining information concerning enemy activities, the aerial camera served to map out in advance the territory through which it was expected troops would move and to reveal the character of the terrain, the nature and the amount of covering upon it, and other useful facts.

New Jersey Highway Commission

SHOWING A CITY BY-PASS

This oblique aerial view illustrates the facility with which such pictures lend themselves to indicating the purpose and scope of either projected or completed highway improvements. The white, jogging line shows the way by which traffic formerly passed through Freehold, N. J., on Route 33, while the fainter line at the left indicates the changes made.

The position of aerial surveying in the United States is more important than is generally realized. According to the Federal Bureau of Aeronautics, there are more than 160 companies engaged in aerial mapping. These concerns furnish most of the photographs for state, municipal, and private engineering studies and projects. Nearly all Federal undertakings are conducted by their own personnels. They involve a vast amount of flying and photography, as they include the activities of the U. S. Geological Survey, the Coast and Geodetic Survey, and the War and Navy departments. Although, as previously stated, the army furnished most of the trained men during the years following the war, this work has now reached the status of a branch of the engineering profession, and special facilities are being established for giving young men the training that it requires. Syracuse University offers a complete course of instruction in aerial photographic surveying and mapping. It has fully equipped offices, laboratories, and field resources. This course was made possible through the collaboration of the Guggenheim Foundation for the Promotion of Aeronautics.

There are two general classes of aerial photographs—verticals and obliques. The latter show the general character of the country and have definite uses; but the appreciable distortion resulting from the angular view renders them too inaccurate to serve for detailed location work. The engineer therefore relies chiefly upon vertical pictures. As each one of these shows only a relatively small ground area, series of them are assembled in the form of a mosaic to produce a composite view of the territory covered. Hundreds of individual prints, termed contact photographs, enter into a mosaic covering an area of considerable size. The piecing together of these prints is an exacting task which calls for experienced and expert hands. To reduce distortion to a minimum, only the central portion of each print is ordinarily used. This necessitates cutting each photograph and properly matching and orienting it in the mosaic with respect to its neighbors.

The original contact pictures are taken so that each one overlaps the field of the preceding one by from 50 to 66 per cent in the direction of flight; and there is also an overlap of 10 to 30 per cent on the side previously photographed. This makes it possible to utilize the principle of the stereoscope—that familiar and wondrous instrument that was to be found in almost every family parlor a few years ago.

As most readers of this will recall, the stereoscope blends two pictures together so that through the glass they appear as one, but with the addition of a third dimension. In order to secure this effect, it is necessary to have an overlap in the photographic field—that is, to photograph objects from two angles of view.

Advantage is taken of this ocular illusion in the study of mosaics. Let us assume that a highway engineer has before him a mosaic which has been assembled as an aid to laying out a new road. He is able to trace the general route on this composite photograph. He then reëxamines each section of the route in detail by viewing overlapping contact prints through a specially designed magnifying stereoscope. This enables him to see that particular localized area in relief, and, accordingly, to correct the preliminary line to meet the topographical

© Abrams Aerial Survey Corp.

A REVEALING VERTICAL VIEW

A photograph made and reproduced to a scale of 1 inch = 400 feet of a section of suburban Detroit. At the upper right is a golf course, the various fairways being distinguishable by the difference in shading of the turf. Trees, creeks, roads, cultivated fields, fences, and other physical features all exhibit individual characteristics which are readily discernible by one versed in reading these aerial photographs. Even the roll of the ground is indicated by the shading, and stands out clearly when overlapping prints are viewed stereoptically.

conditions. After the route has been laid out on the mosaic, a field study is made. It is usually possible to follow the line without difficulty; and it becomes a relatively simple matter to make minor corrections in alignment and grade.

So far as time is concerned, the actual taking of the photographs comprises but a small part of the complete process of making a mosaic, but it goes without saying that all subsequent steps depend upon the work of the camera man. An aerial photography crew is usually made up of two men, the pilot and the photographer. A special type of camera is used, and it is mounted on a swivel in such a manner that photographs are taken vertically through a hole in the bottom of the airplane fuselage. The film is very rapid and sensitive to color gradations. It comes in rolls containing about 110 exposures, each one of which makes a picture measuring 7x9 inches. Cameras may be automatically operated by electric motor so that they will take pictures at predetermined intervals, or they may be cranked by hand. Most operators use the manual method, as it is necessary in either case for a man to be at the camera. To reduce distortion. it is essential that the camera be nearly level at the instant of exposure. Bubble levels are provided to show when this condition obtains; and a recent development which promises to be of considerable value in this connection is the application of the gyroscopic stabilizer.

A great deal depends upon the skill of the aviator. If the scale of the pictures is to be constant, the plane must be kept at uniform height. If the overlap of successive pictures in the direction of flight is to be the same throughout the series, there must be no variation in flying speed. As the pictures are taken in series of parallel flights, it is necessary that the pilot maintain a true line. Oftentimes he must fly as far as 50 miles, turn around, and fly back to the starting end on a straight line paralleling the first one but from half a mile to two miles distant. Occasionally a navigator is added to the crew to help keep the plane on a true course. If an extensive area is to be covered, numerous flight strips of this kind are involved. Meanwhile, the camera man must be taking pictures at the proper intervals. Depending upon the scale of the photographs desired, the camera shutter must click from two to six times a minute. When it is considered that flights may last several hours, and that the altitude sometimes is so great as to subject the crew to intense cold, it will be realized that these men work under exceedingly trying conditions.

Cloudless skies are essential to satisfactory photography, and this condition must be awaited before a start can be made. Depending upon the climate and the season of the year, favorable weather may be a week or more in arriving. But, since flying is expensive and wasted moments are costly, the crew must in the meantime hold itself in readiness to go aloft upon short notice. In Canada the normal expectancy of suitable atmospheric conditions is one day in seven, and the average working period per day is 2½ hours. Best results are obtained when the sun is high in the sky, as shadows are then at a minimum.

The scale of the photograph is the ratio of the focal length of the lens to the height above the ground. Thus, if the focal length is 12 inches and the plane is 6,000 feet up, the scale will be 1 to 6,000. In rugged country the scale will of course vary as between elevated and depressed areas because of their differing distances from the camera. As an aid to maintaining a uniform height, the pilot ordinarily uses an altimeter. However, to assure closer control of this factor, some planes now carry aneroid barometers and recording barographs which are calibrated to show elevations above the earth and are compensated for temperature changes. Barometric changes on the ground during a flight are communicated to the plane by radio so that further compensation of the instruments may be made and variations in flying height reduced accordingly.

Distortion will vary directly with the tilt of the camera. By careful collaboration, a skillful pilot and expert photographer can reduce

New Jersey Highway Commission

PROJECTING A NEW HIGHWAY

This oblique aerial study was made by the New Jersey State Highway Commission in connection with the construction of Route 29, which is indicated by the dotted line. This road, which carries heavy traffic into and out of New York City, was laid out to escape the congestion encountered along the route of the earlier road, which is indicated by the solid line. Notice how clearly cultivated areas are differentiated from mountainous sections and how railroad tracks, streams, property lines, and even individual buildings stand out.

this inclination to one degree or less. Distortion around the edges cannot be avoided on account of the increasing distance from the camera and the curvature of the lens. With the aid of ingenious devices, one of which is illustrated, it is possible to correct this distortion by photographic processes in the laboratory.

The scale to which photographs are taken varies with the purpose for which they are to be used. As the field of the lens increases with the height, the number of pictures required to cover a given area decreases at higher altitudes and, in the interest of economy, the elevation is made as great as is consistent with securing photographs that will satisfactorily answer their intended purpose. Pictures have been taken from as high as seven miles above ground, and a great amount of work is done from two or three miles up.

An effective scale seems to be 1 inch to 400 feet, which is equivalent to taking pictures from an elevation of 4,800 feet with a camera having a 12-inch focal length. The same results can be obtained, of course, by making the photographs on a scale of 1 inch to 800 feet and by enlarging them 100 per cent in the laboratory. In any event, a large number of exposures is required. Assuming a focal length of 12 inches, a flying height of 5,000 feet, and a 7x9-inch film with the 7-inch side in line with the line of flight, each picture will cover a ground area about .55 mile in the direction of flight and .7 mile in the other dimension. Allowing for an overlap of 50 to 60 per cent in the direction of flight, and assuming a speed of 60 miles per hour for the plane, it would be necessary to make an exposure every thirteen seconds.

Although it calls for expert craftsmanship, the taking of pictures is looked upon primarily as a means to an end, the plane being considered in the light of a conveyance which makes the field work possible. As already stated, the engineers who use the maps seldom take the pictures. This is done under contract by commercial aviation concerns; and in many sections of the world there are enough of them to insure competitive bidding on all jobs of considerable size. Prices vary widely according to the scale and degree of accuracy desired, the distance of the work from the flying base, the normal expectancy of suitable flying weather in the area concerned, and other factors. One firm, which specializes in aerial surveying and which has had twelve years of experience in the business, places the cost of all ordinary work of this type at from one to ten cents per acre. A mosaic of New York City which was made in 1924 cost $60 a square mile. One of a portion of Los Angeles, involving only seven square miles, figured $250 to the square mile. In any case, the expense is considerably less than it would be if the same information were obtained by ground methods.

In a paper delivered before the technical section of the American Road Builders' Association last winter, Talbert Abrams, president of the Abrams Aerial Survey Corporation of Lansing, Mich., discussed the salient features involved in preparing a usable field map from photographs. The first step is the correction of distortion, which ordinarily amounts to no more than 2 or 3 per cent. By means of special apparatus developed for this purpose it is possible to make from the original negatives prints of either greater or smaller scale and to take out distortion caused both by the tilt of the camera and the curvature of the lens, giving rise to prints that are of uniform scale all over. "This," said Mr. Abrams, "is absolutely necessary if accurate maps are to be produced. Humidity in the laboratory is carefully watched to prevent unusual expansion or contraction of the negatives and prints.

"If field notes or reasonably accurate maps are available, this information is used when laying up the strip or mosaic maps. If they are not available we go into the field, and by ground methods secure a limited number of measured distances sufficient for control and orientation. This information is then projected on our base to the desired scale, and the aerial

CONTRASTING SECTIONS

The view at the left shows the intersection of two roads in Atlantic County, New Jersey, which traverse heavily wooded country. Below is a section of the elevated super highway which enables traffic between Newark and Jersey City to move at high speed across a stretch that was formerly slow and difficult to travel.

New Jersey Highway Commission

photographs are made and laid to that scale. The result is that any mistakes in the field notes are immediately noticed and corrected on the aerial map, and if there are errors in the aerial photographs they are corrected by the field notes. In the end we get a map that is more accurate than one secured by either method alone.

"Through the use of the stereoscopic 'contour finder,' it is safe to say that the use and value of any aerial survey can readily be doubled. This instrument gives about four-power magnification and makes the study of detail correspondingly easier. Everything stands out in bold relief, fine in detail. With the contour finder, an engineer in the drafting room can complete a contoured map of exceptional accuracy with very little ground control. The time required will be about one-tenth that usually necessary for such work.

"An aerial mosaic can be used in the office in much the same manner that a survey is conducted in the field. The mosaic is oriented as to direction, and the azimuth carefully plotted from known ground objects. Instead of a transit, a protractor and conventional drafting instruments are used directly on the mosaic or contact prints. Relief is subjected to careful analysis under the contour finder, and several preliminary lines are laid out. Sometimes an aneroid is used in the field to get control on the high and low points, and the intermediate contours are drafted in by comparison. Using this small amount of field vertical control as a base, profile lines for comparative cost estimates are available, and a decision is made in the office on a final line which requires only staking in the field. The advantages are many. Every possible location has been given consideration. The human element has been reduced to a minimum."

When aerial surveying was in its infancy, it was believed that it would be confined almost exclusively to open country, but experience has proved that it is well adapted to work in cities, particularly as it reduces ground operations in congested areas to a minimum. In the United States, aerial photography finds its greatest field in connection with highway work. Many states are regularly using it, and there is no longer any doubt that it saves both time and money. It is not considered to be competitive with ground methods, but rather supplemental to them. By availing themselves of its services, highway engineers are able to locate roads more intelligently than ever before and in a fraction of the time formerly required. The shortest route consistent with the topography and other controlling factors is made instantly apparent by an aerial mosaic. An example of how it simplifies preliminary engineering problems is contained in a statement by Harry L. Brightman, reconnaissance engineer for the Michigan State Highway Department. He says:

"We have developed this work now so that we can prepare a preliminary map to a scale of 1 inch to 400 feet from which a ground party can stake the actual center line of the future highway improvement without preliminary field work and mapping. Recently I prepared such a map of a section about three miles long which will save about $300 in preliminary survey costs. My own preliminary work consisted of one day in the field and one day in the office.

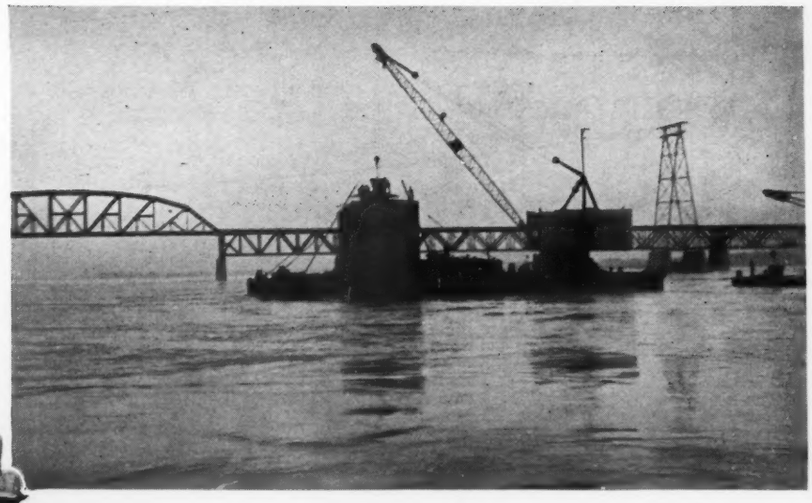
"The general public has not yet been educated to the value of these aerial maps and to the variety of purposes for which they may be used. Their cost is really so small, considering the information obtained, that one who does not use them is actually throwing away two or three times their cost by employing ground methods only."

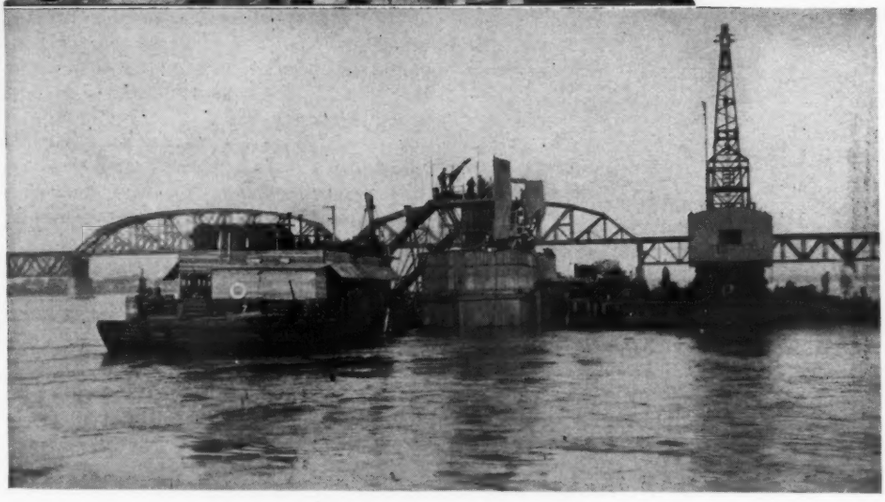
In addition to their direct use in location work, aerial photographs and maps render other valuable services. They are particularly helpful in studying stream embankments to determine the most suitable bridge sites. They also make it possible to measure closely the watersheds of drainage courses and to calculate therefrom the maximum run-offs so that culverts and bridges can be intelligently and economically planned. In a similar manner, they assist in studying grade-separation problems. They excel any other method for taking traffic counts of roadways. Oblique views, which cover great expanses of territory, frequently suffice for the purposes just mentioned.

The mosaics can often be used in plotting property which must be secured for rights of way. In this connection it is worthy of note that an aerial survey can be made without land owners becoming aware of it and organizing among themselves, thereby forestalling any attempt to obtain more than a just price for the property. Where controversy arises over the location of a road, or where propaganda is brought to bear upon the authorities to route a highway according to the wishes of a certain group or community, a mosaic serves the valuable purpose of demonstrating clearly the most feasible line and thereby tends to divorce matters pertaining to the locating of highways from local politics.

Bridge Piers and Sand Hogs

R. J. DUSTAN





SAND HOGS AND SCENES OF WORK

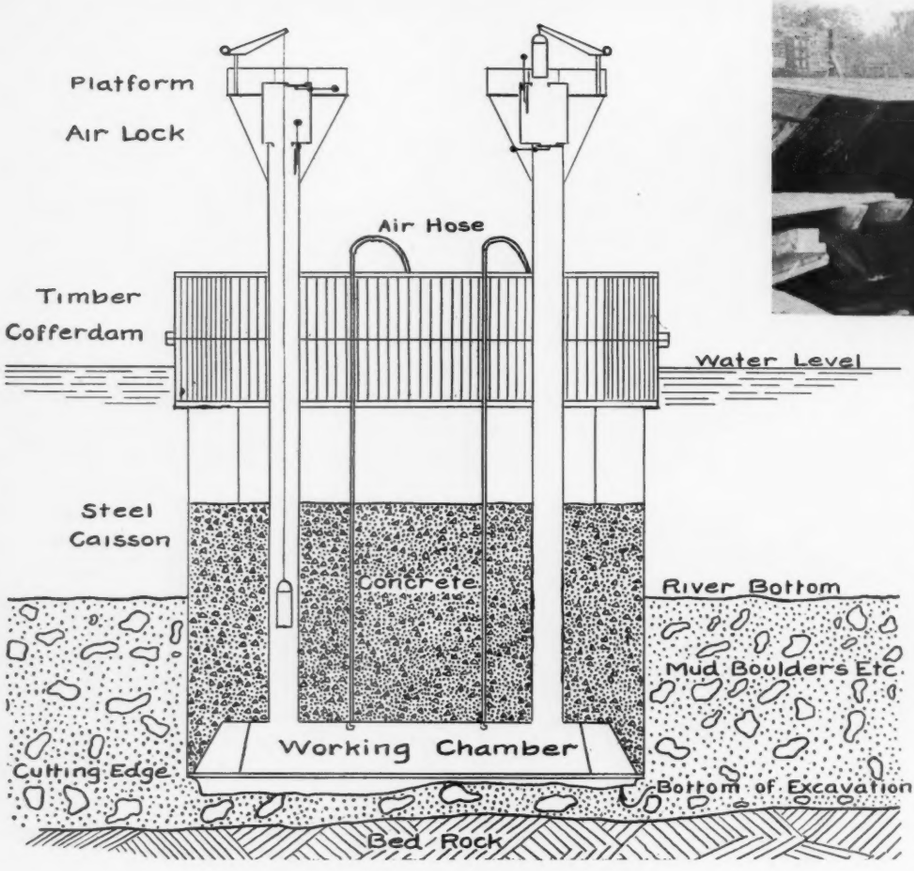
The caisson shown above is being loaded with concrete to sink it to the river bottom. The bottom picture shows the same caisson with all its steel frame submerged and a wooden cofferdam constructed on top of it. Standing by are a scow, carrying compressors, and a derrick. In the center is a group of sand hogs. Caisson work is a he-man's job. The examining physician weeds out those applicants that are physically unfit, and a few shifts in the "box" discourage all those that are not stout-hearted.

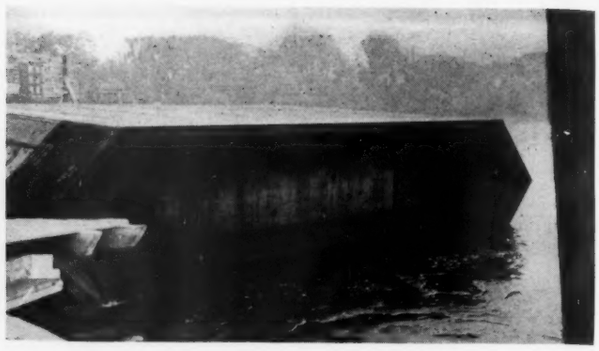
A FAMILIAR sight in any large city is a group of intent, fascinated persons rimming an excavation where power shovels and other machinery are at work. A construction job of any kind is interesting, for it is a scene of intense, highly organized activity. Most impressive of all such undertakings, perhaps, is a great bridge in the making across a mighty river—the current swirling about its masonry piers, and its partly formed steel superstructure outlined against the sky. Although big bridges represent notable triumphs of man over the forces of nature, few of the thousands that use them give much thought to how they came there. The layman, if he ponders the matter at all, usually visualizes steel erectors balancing themselves on narrow beams at dizzy heights, or guiding great steel members into their appointed places as they hang by slender wire ropes from lofty derrick booms. There is, however, another side to bridge building which, while not so spectacular, is none the less arduous and dangerous and calls for the highest degree of skill and judgment. This is the placing of pier foundations on bedrock, far below the surface of the deep, swift-running current and even below the river bottom, itself. Here is the field of the pneumatic caisson, and the realm of the sand hog.

The general features and operating principle of the pneumatic caisson have been described in this publication at various times. As applied to bridge-pier foundation work, it is essentially a huge steel cylinder the shape of the pier of which it eventually becomes a part and deep enough to reach from the water surface down to the material being excavated. Built into its lower end is a working chamber, a compartment without a bottom. There, while compressed air keeps the water from entering, the sand hogs do their digging. Excavated materials are hoisted through shafts surmounted by air locks; and the men, themselves, must use the same passageways when entering or leaving the working chamber. Above the chamber, the caisson is filled sufficiently with concrete to cause it to stay on the bottom but not to be so heavy that it will sink too fast in soft material. As excavating proceeds, additional concrete is deposited as required. The caisson, in order to sink, must overcome not only the buoyancy of the displaced water but also the friction of the material through which it passes. The weight of the displaced water can always be calculated and the caisson loaded to offset it, but the friction factor is rather difficult to determine accurately. To be on the safe side, the practice is to overweight rather than to underweight. As depth increases, the air pressure must, of course, be raised sufficiently to overcome the added hydrostatic head.

A new highway bridge, known as the Lake St. Louis Bridge, is now nearing completion across the St. Lawrence River a short distance west of Montreal, Canada. Between abutments it is 4,500 feet long. The steel superstructure is supported by thirteen piers, eleven of which were carried to bedrock by the pneumatic-caisson method. The writer had the interesting experience of assisting in the caisson work, which was done by the Foundation Company of Canada as subcontractor for A. Janin & Company Limited, which has the general contract. The entire undertaking is in charge of the Lake St. Louis Bridge Commission, appointed by the Quebec Government; and its engineers planned the bridge and are supervising its construction.

The steel caissons were supplied by the Dominion Bridge Company. Four were built at the scene of operations; the remainder were made up at the company's plant on the Lachine Canal and floated to the bridge site. Three of the latter were floated on their sides





CAISSON SECTION AND WORKING CHAMBER

The sketch indicates the manner in which caisson work is conducted. In the air lock surmounting the left-hand shaft the bottom door is open and the top one is closed: in the right-hand lock this condition is reversed. The photograph shows the steel shell of a caisson as it was floated on its side to one of the pier sites. The working chamber end is foremost, with its shaft openings and pipe orifices visible. This caisson is 14x62 feet in cross section.

like scows by partly planking up their open ends, and then righted at their sinking locations by a floating crane: the others were moved in an upright position lashed alongside scows.

To provide access to the piers, a timber-pile trestle was built out into the river as far as Pier 9. The remaining four were served by floating equipment. As the current ran as much as five or six miles an hour in places, an elaborate system of steel bracing was necessary for this trestle.

A still-water basin had to be provided for each caisson to facilitate its sinking. This was accomplished by running two small side jetties out from the trestle at each caisson site as far as Pier 9. These jetties were loaded with rock, and stop-water planks and sheet piles were arranged so as to break the current and to form the desired basin. The piers built beyond the trestle were each protected by a large steel-and-concrete current deflector shaped very much like the bow section of a canal steamer. This was made heavy enough to stay put in the swift current, which, in one case, was 30 feet deep. In addition to the current deflector there was also on each side of a caisson a small pile wharf similar to the jetties extending out from the trestle.

All the piers built from the trestle were served by an air-compressor plant on shore through pipe lines run out along that structure. The concrete of which the piers were constructed was supplied by the Ready Mix Concrete Company of Montreal. It was hauled from the Montreal plant in mixer trucks, moved over the trestle in motorized concrete buggies, and raised above the caissons by regular concrete elevators using compressed-air hoists. Pier 10, just beyond the end of the trestle, also obtained its concrete from the same source. A floating derrick and a floating crane passed it from one to the other across the water gap and dropped it into the caisson. The other piers were served by floating equipment, including compressors and concrete mixing plants to which latter sand and stone were delivered by scows as needed.

The Foundation Company had a lot of floating equipment at work, the principal units being the *Foundation Scarborough*—capable of lifting 250 tons on two pairs of sheer legs—which handled the current deflector and also supplied air from her compressor room when it was required, and the *Foundation Masson*, a floating crane that was in continual demand for all sorts of jobs.

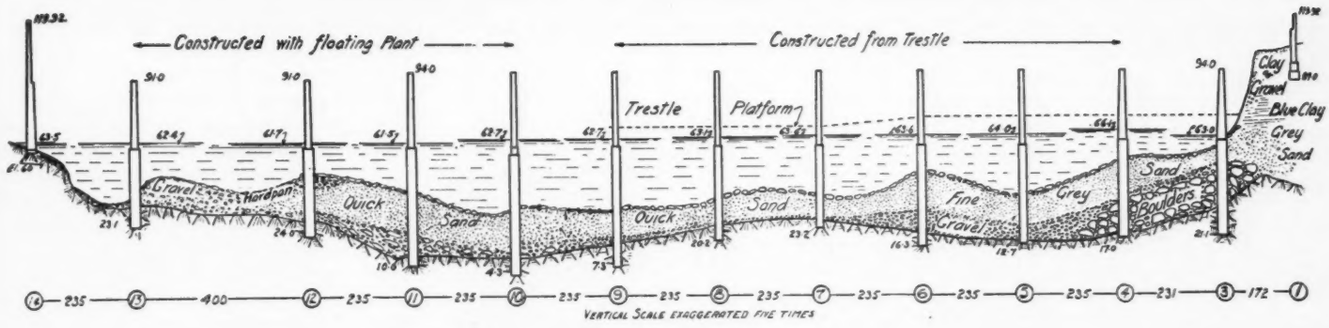
Compressed air for the caissons was supplied from three sources. The shore plant contained a Canadian Ingersoll-Rand 14&9X12 Class ER-2 compressor of 528 cfm. piston displacement for furnishing 100-pound air, and two low-pressure units having a combined capacity of 1,662 cfm. at 30 pounds. One of the latter machines was an 18x10 Class ER-I unit. This plant supplied two caissons having working chambers of 14x62 feet. The maximum working pressure attained was a little more than 20 pounds.

The *Foundation Scarborough* carried three motor-driven compressors: two Canadian Ingersoll-Rand 2-stage Class ER compressors having capacities of 528 cfm. each at 100 pounds and convertible for low-pressure work to capacities of 730 cfm. at 30 pounds, and a 20x12 Class ER single-stage unit having a capacity of 1,048 cfm. at 30 pounds. Power for operating them as well as the hoisting machinery and deck capstans came from diesel-engine generator sets.

A scow housed a battery of four Canadian Ingersoll-Rand Type Twenty 10x8 oil-engine-driven compressors, each with a capacity of 310 cfm. at 100 pounds, and, as standbys, had two gasoline-engine-driven portable machines also of 310 cfm. capacity each. These compressors could be used for either high- or low-pressure service. This plant supplied one of the larger caissons having a working chamber of 18x72 feet. Working pressures ranged up to 27 pounds.

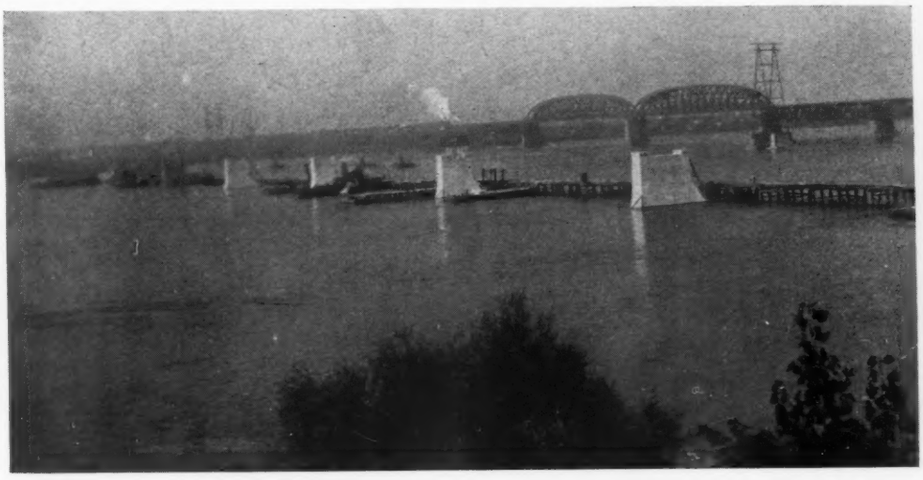
Two distinct air lines led to each caisson: the high-pressure line that delivered air at about 100 pounds to run the hoists and the pneumatic tools, and the low-pressure or main air supply for the working chamber which, on this job, varied from 9 pounds up to 27 pounds or so.

I went to work on the night shift—midnight to 8 a.m.— on a hot, close, dark night in June. The long trestle, brilliantly lighted, extended far out across the black water of the river to where caissons Nos. 6 and 7 towered above it crowned with great clusters of lights. At the shore end of the bridge the air throbbed with the intermittent booming of the compressors forcing air out to the caissons, while from mid-river came faintly the whistle blasts and sharp hammer knocks of the caisson signals, followed by the metallic crash of stones sliding down the steel dumping chutes. Groups of husky fellows in clay-daubed working rig, the turned-down tops of their rubber hip boots flapping around their calves, were streaming out along the trestle and swarming up the wide wooden ladders on the sides of the caissons. They were the sand hogs going on shift.



METHOD OF CONSTRUCTION

A trestle was built out into the river to serve the piers as far as No. 9. In order to maintain a channel for navigation, the remaining four piers were served by floating equipment. Above is a cross section of the river, showing the positions of the piers and the contour and character of the river bottom. The lower sketch illustrates how the trestle and adjoining still-water jetties facilitated caisson operations. In the center is a general view of the pier work as it neared completion.



My job, that of gauge tender, was to watch the air pressure in Caisson 7 and to control the supply, a really responsible post, as can be readily understood. On this caisson the gauge and control valves were situated on one of the working platforms built around the air locks. In the case of those following No. 7 the valves were placed either on the jetty or on the current deflector.

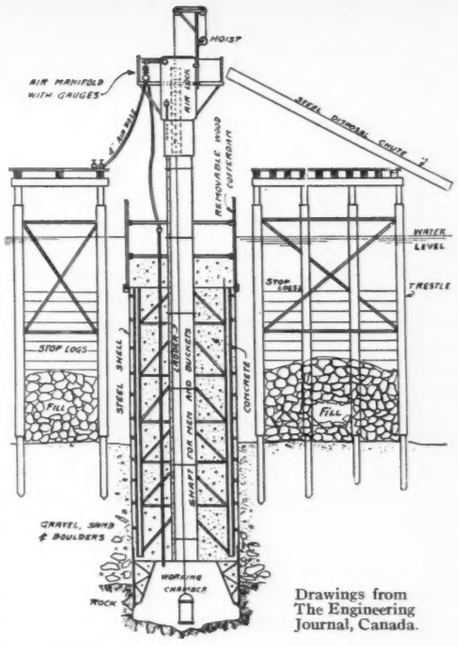
The top of each air lock, shaped like the end of a boiler, rose a foot or so above the platform, which was strongly constructed of rough lumber. The round door was open and the sand hogs were dropping through it to the accompaniment of rapid-fire French repartee. It seemed incredible that so many men could wedge themselves into that tiny space. However, it was soon accomplished, and the door swung up into place.

The air was then turned into the air lock, the heavy steel-plate door noticeably swelling under the pressure. When the pressure had been equalized between the air lock and the working chamber, the lower door was opened by one of the platform crew by means of a long lever connected with the door counterweight and the shaft made available for the descent of the shift.

There was a wait then which enabled me to take stock of my surroundings. We were high above the river on top of the caisson, in the center of a little pool of garish light in a vast sea of darkness. There were three men on the platform besides myself: the lock tender in charge, the hoist runner who ran the "Little Tugger" air hoist for handling the buckets, and the nipper who helped the lock tender open and close the lock doors and swing the bucket around to the dumping chute. The bucket, meanwhile, was clear of the lock, hanging from the end of the crane.

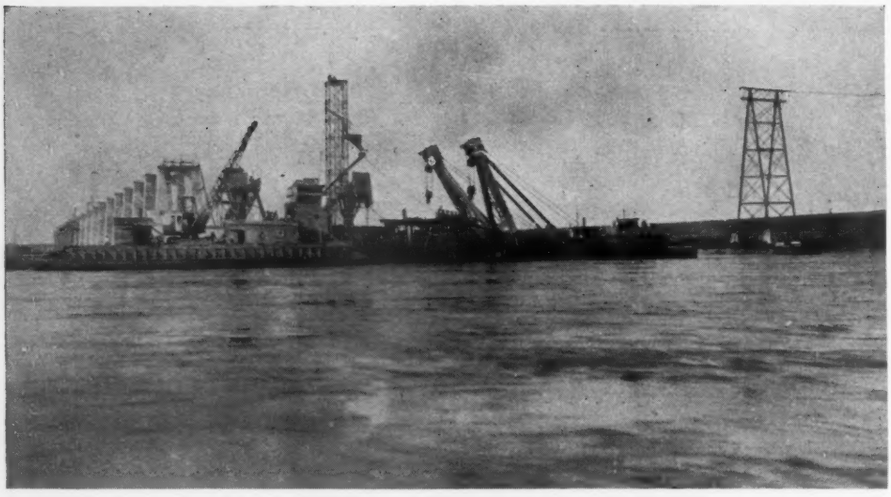
After a few minutes, five sharp raps sounded from inside the air lock and were repeated immediately by the lock tender with a short iron hammer. This meant that the men who had finished their shift in the caisson were ready to come out. The lower door was closed and the air allowed to escape slowly from the lock in order to give the sand hogs the necessary period of decompression. When the pressure had been reduced to atmospheric pressure the upper door was swung open, but the lock was so full of white vapor that it was impossible to see what was going on inside, the lights just glowed dully through it. However, the sand hogs quickly appeared, popping out like so many jacks-in-the-box. They were covered with clay and sweat, for it was hot inside. They lost no time in scampering off along the trestle for the sand-hog house at the shore end of the bridge. Awaiting them there were shower baths, dry clothes, quantities of hot coffee, and a decompression chamber to take care of possible cases of "bends."

The bucket was now swung into the air lock, the upper door closed, and the bucket locked through and lowered. Routine work was then resumed and carried on with concentrated speed and energy under the crude glare of unshaded electric lights and to the accompaniment of a medley of the harshest noises to which I have ever been subjected. The signals from below were given on an air whistle just under the platform, using the compressed air in the caisson. The lock tender signaled by striking the steel drum of the air lock with a hammer. The open exhaust of the fast-running little air hoist fairly shrieked. The ascending bucket would announce its arrival in the air lock with a series of hollow thumps, to be followed instantly by the terrific blasts of the suddenly escaping air from the lock valves, dominating and dwarfing all other sounds. The bucket, containing about half a cubic yard of stones and dirt, was then dumped down a sheet-iron chute.



Drawings from The Engineering Journal, Canada.

Caisson work is a he-man's job. The sand hogs were all carefully picked young men, a sort of laboring elite, and had to pass a very rigid physical examination. The lock tenders usually were experienced sand hogs who had failed to pass this test for some reason. I was particularly impressed by the man in charge of the lock where I was posted. He was a young man, very handsome in a dark, moody sort of way. The most striking feature about him was his tremendous shoulders—they fairly seemed to weigh him down. He worked with an intent ferocity, flinging the heavy air-



FLOATING EQUIPMENT

A 250-ton work boat, especially designed for handling and sinking caissons, was among the large fleet of floating equipment used. Aboard this craft, the *Foundation Scarborough*, were both high- and low-pressure compressors. It is shown here at work, together with a derrick, concrete mixing plant, and other essential equipment.

lock door open and shut and pushing the great steel bucket around as if they were toys.

During the rare intervals when the hoist was quiet for a while, because of some hitch down below, he would sit relaxed on top of the air lock in a curious collapsed attitude, his great shoulders hanging forward, chest caved in, staring into the velvety blackness of the summer night with a completely blank expression. He was extremely taciturn, and it was difficult to get a word out of him at such times. But at the first blast of the air whistle, or the tinkle of the telephone bell, he would spring into instant activity.

My own job, as I have already mentioned, was to maintain a uniform pressure in the caisson. This was increased a little from time to time in accordance with instructions telephoned up from the working chamber. It meant constant attention in any case, as the demand for air was continually varying for one reason or another; but there were several ticklish situations when one had to keep screwed up to a really painful pitch of concentration for hours at a stretch.

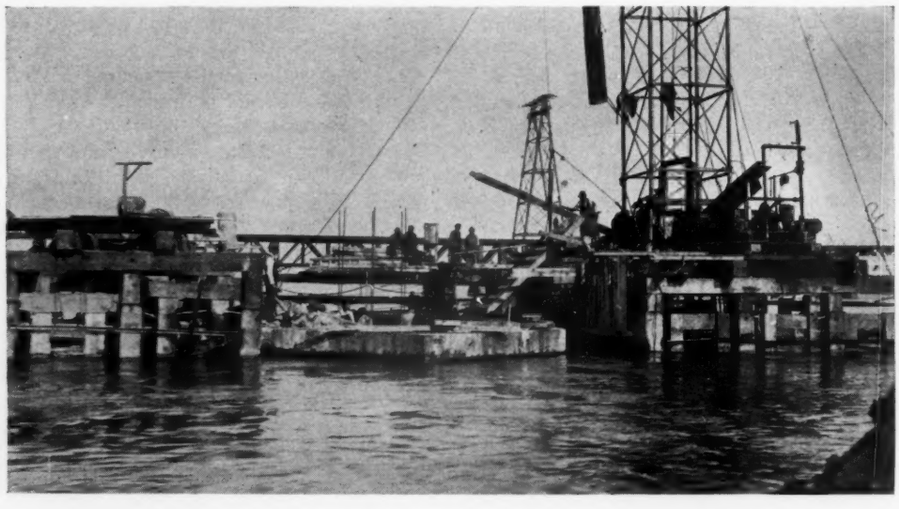
There was a certain attraction about the work at night with its striking effects. At one period I was working on Caisson No. 13, and between it and the next caisson in operation—No. 10—lay a wide stretch of empty river. The trestle, as stated before, ended at No. 9, and from my post I had a foreshortened view of it, a brilliant band of light on the black water. On top of piers Nos. 8 and 9 were batteries of powerful spotlights to illuminate the area around No. 10. One of the latter's air locks was squarely silhouetted in dead black against this dazzling bank of lights. As the caisson was in its initial stages, there were no screens around it, and it stood out in stark outline, the platform grimly suggestive of a scaffold. It required no stretch of the imagination to fancy the black figures moving about it to be the hangman and his assistants, while the crane with its dangling bucket made a most realistic gallows. Dull thuds of mighty hammer blows, bringing to mind the legendary hammer of Thor, came to me from time to time, breaking through the bedlam of noises of which I seemed to be the core.

The work went on 24 hours a day, in shifts, which, for the sand hogs, varied according to the pressure—eight hours with a half-hour lunch period up to 22 pounds, and from that pressure up to 30 pounds, three hours in the "box," three in the sand-hog house, and three in the box again. I didn't see the pressure reach the next stage where the hours of labor were shortened to two. The outside crews worked 8-hour shifts.

There were about fifteen sand hogs on each shift under a foreman who remained in the box. Each caisson had a day superintendent and a night superintendent, who divided their time inside and outside as circumstances dictated. They had to watch carefully the position of the caisson as it settled, and direct the work so that it remained in correct line, frequently a matter calling for much skill and judgment. The clay used to seal the excavation and to confine the air below the cutting edge was specially brought to the work and delivered to the caissons in bags for convenient handling. The lock tenders sent it below in the empty buckets when it was called for. No end of ingenious dodges were resorted to to control the caisson and to keep the work running smoothly. Although I didn't go below, I was always kept informed of what was going on and warned what to look out for.

As compressed air was available in any desired quantity, full use was made of air tools in the box. Pavement breakers took the place of pickaxes, and air-driven rock drills were employed to put holes in the rock for the blasting charges. It was necessary to do a lot of shooting at times to break up bowlders and to prepare foundation beds. On these occasions, when everything was ready, the gang would come up in the air locks and signal with the usual hammer blows. The lower doors would be closed and the lock tender would fire the shots by plugging in an electric circuit. The mass of steel and concrete in the caisson was so great that the only effect felt outside was a slight bump. For a big round of shots, however, the crew would leave the caisson and not enter it again until the fumes had been blown out by manipulating the air valves. The foundations were all keyed deeply into the solid ledge after the caissons had been lowered to full bearing on rock. In some cases shale rock was excavated to a depth of 12 feet or so below the cutting edge to reach a sufficiently firm footing.

Although it was customary to keep the caissons heavy, it sometimes happened that one would be too light owing to the sinking running ahead of the concreting. In the latter case, if it refused to sink, the gang would be called out and the air pressure lowered



FINISHING OPERATIONS

The caisson in the center of the picture has been sunk to bedrock. The shaftways and air locks have been removed, and only the top of the surmounting cofferdam is above water. Workmen inside it are preparing the forms to receive another lift of concrete. The cofferdam will be dismantled and floated clear when the pier is above water.

suddenly, partly flooding the working chamber. The resulting loss in buoyancy would do the trick and cause it to subside. This was a fascinating thing to watch from a position on the low jetty alongside the caisson. The great bulk would slowly and silently settle two feet or so as though an invisible giant hand had reached out and pressed it into the river. The restoration of the pressure would drive out the water in the working chamber and the crew would go below again.

When sinking a caisson through a thick stratum of clay, this stunt is sometimes worked from inside the caisson. The excavation is carried 2 feet or so below the cutting edge, leaving a margin all around for a seal, and two valves are manned by particularly reliable men. At the word of command one valve is closed, shutting off the air supply, and the other opened, allowing the compressed air in the caisson to escape. The air goes out with a blasting roar which completely drowns the human voice—the sudden drop in pressure at the same time filling the working chamber with a dense, white vapor that the eyes cannot penetrate.

The man in charge stands with his arms extended above his head to feel the roof descending on him and to gauge its height. When it is low enough, he signals to the escape-valve tender by slapping him on the back. The valves are then reversed, restoring the air pressure. The risk here lies in the fact that if the escape of air isn't checked in time the working chamber will be buried in the clay.

The opposite condition is an overheavy caisson, and this made it necessary on occasions to support the box on timber blocks so that it wouldn't sink before everything was in order. These blocks were short sections of 12-inch square timber. There was one memorable instance of this kind in connection with No. 9 Caisson. The cutting edge was in a stratum of gravel and bowlders about 3 feet above the surface of the rock. The sand hogs had been removing this stuff for days, carefully sealing the sides of the excavation with clay and putting in timber props to support the weight of the caisson, which was overheavy. What made it so awkward was the fact that a number of bowlders were partly under the cutting edge, and shooting these out and clearing them away was a delicate job.

A situation finally developed where the excavation extended down to the surface of the ledge, with a clay wall about 3 feet deep all around under the cutting edge. The whole weight of the caisson rested on blocks, and several bowlders still remained to be shot and cleared away. Under the circumstances, a very delicate balance had to be maintained between the air pressure on the inside of the clay walls and the water pressure outside. A slight variation might have been disastrous. If those clay walls had been pushed in or forced out as the result of unequal pressure, the hard won 3 feet not only would have been flooded up to the cutting edge but the caisson, owing to the great loss in buoyancy, might have crushed the blocks and dropped prematurely.

There were two superintendents on the job at that time, and for about six hours I scarcely took my eyes off the gauge and my hand off the valve wheel. All the while one or both supers prowled around behind me watching the gauge, and about as easy in their minds as a cat on hot bricks. However, everything went perfectly, the bowlders were shot away, and then the posts—previously bored for shot holes—were charged and all wired up together. With all this done, everyone came out of the caisson for the big drop.

My post was on the jetty at an elevation about 8 feet above the water level, the top of the cofferdam being some little distance below me. When the shots were fired, the whole caisson dropped like a stone with one bump, and the imprisoned air blew out through 15 or 20 feet of clay, stones, sand, and mud and 20 feet of water right under where I was sitting. A great geyser of solid water went over me, washing numerous small articles off the jetty. Many tons of water flooded the top of the cofferdam, and hours were spent afterward in pumping it out.

On another occasion, when a somewhat similar drop was impending and I was expecting the sand hogs to come out preparatory to firing the shots, a blowout suddenly occurred. While I was whirling the valve open to try to offset the air loss, the caisson suddenly began to pitch and roll like a ship at sea, bumping down 2 feet or so first on one end and then on the other, with white water flying up all around. This gave me a bad shock, thinking it might have been my fault somehow; but as a matter of fact the superintendent had elected to cut away the blocks instead of shooting them, and hardly a barrel of water had entered the working chamber.

The superintendents naturally were hard-bitten men who had worked on big compressed-air projects the continent over and had every trick of the game at their fingertips. The sand hogs included a number of men of similar type and background; and one could hear scraps of arguments in the sand-hog house about well-known engineering jobs throughout Canada and the United States. Most of them were French Canadians recruited from the labor market around Montreal. They were fine physical specimens such as can be assembled only on a job of the kind in question.

Making Red-Oak Kegs Leakproof

COMPRESSED air is making our abundant stands of red oak available for use in beer kegs and barrels, where white oak alone has previously been employed. This may sound far-fetched, but it is nevertheless a fact, according to the U. S. Forest Products Laboratory at Madison, Wis.

Both red oak and white oak contain extremely large pores. Those in white oak are effectually sealed during growth by a froth-like substance, but in the case of red oak Nature neglects to provide it.

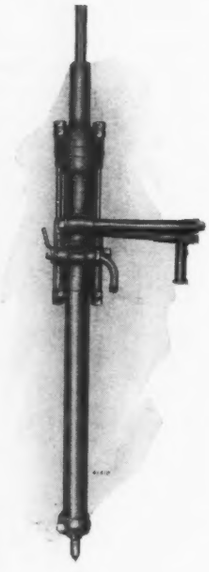
Casks made of red-oak staves accordingly permit gases and liquids to escape, although in every other respect they are as suitable for the brewer's purpose as those of white oak.

The leakage takes place chiefly around the croze, which is the groove cut into the inside faces of the staves near the ends to form a seat for the barrel heads. The pores run longitudinally through the staves, and the croze provides them with an outlet. The problem, then, was to seal the pores, and this has been accomplished by applying ordinary brewer's pitch with compressed air.

In making the barrel, the croze is coated with hot pitch by hand before the heads are put in place. When the barrel is completed, a hose leading from a closed pitch-heating tank is connected with the bung. The barrel is filled with pitch by applying air pressure to the tank, the air in the barrel being vented to atmosphere through a petcock in the spigot hole. When the charging operation has been completed, the air pressure is increased to 30 pounds and held at that point for from five to ten minutes, to force the pitch into the wood. The pitch is then drained out by gravity. Red-oak kegs thus treated have proved satisfactory in service tests made by the Blatz Brewing Company of Milwaukee, which has co-operated with the Forest Products Laboratory.

NEW I-R STOPEHAMER FOR HARD-ROCK MINING

A NEW hand-rotated type of stopehamer for general mine work in hard rock has been announced by Ingersoll-Rand Company, 11 Broadway, New York City. The advantages of the N79, as it is called, are listed by that company as follows: Simple, single-tube construction makes blower tube unnecessary; rotating handle contains automatic lubricator and push button for controlling the air feed; full air-cushioning of the piston eliminates springs and, incidentally, movement of joining surfaces; the well-supported piston is reversible, proportionately increasing its service



period; intermediate lugs on large-diameter, 1-piece through bolts prevent the back of the drill from coming apart when changing front-head; air pressure keeps cuttings out of front-head and prolongs the life of the drill; high drilling speed is obtained by using a flapper valve that is light, sensitive, positive in action, and protected from injury. Like all the other I-R stopehamers, the N79 has renewable anvil-block and feed-piston bearings, single-throttle control, a simple air strainer, and swivel hose connections. Further information about this drill is given in Folder No. 2051, which may be obtained from the manufacturer.

MACHINE REMOVES SOFT MATERIAL FROM CONCRETE AGGREGATES

TO MEET the present-day rigid specifications for concrete aggregates, the Knickerbocker Company, Jackson, Mich., has designed and is prepared to furnish a machine that is said to segregate from bank-run material such undesirable soft stone as ocher, sailers, chalk, lignite, sandstone, etc., and to do this at a low cost and with a minimum of breakage of good material.

The Knickerbocker soft-stone eliminator, as it is called, consists essentially of a rotor having impact bars of especially heat-treated steel and revolving in a vertical plane within a casing. The machine is interposed in the line of production, and the material—from which the sand has been removed—is fed into it through a 15-inch opening at one side while water is introduced at another point.

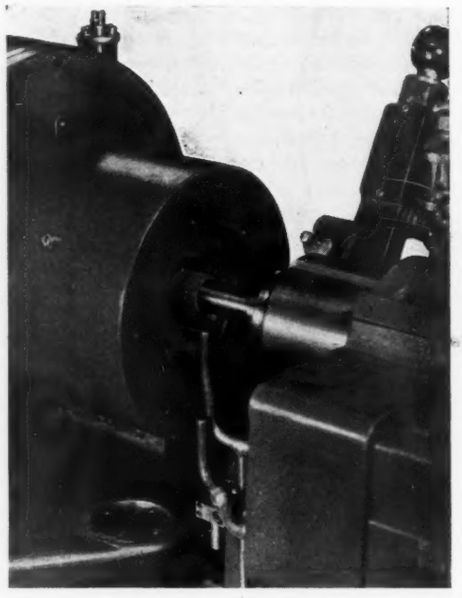
During their journey in the separator, the stones strike repeatedly against the impact bars and, by rubbing against one another, are subjected to abrasion before they are discharged through a bottom opening generally on to a sizing screen. The soft material is pulverized in the process and runs off in the form of a thick sludge. The eliminator is operated by a 20-hp. motor and has a capacity of from 50 to 90 tons an hour.

FLEXIBLE AIR-SIZING DEVICE FOR PRECISION GRINDING

FOR automatic sizing in connection with precision grinding operations, the Landis Tool Company, Waynesboro, Pa., has developed a device that can be used with equal facility for a wide variety of internal and external work regardless of the character of the surface being ground. The Landis air-sizing device, as it is called, functions on the principle that if compressed air is escaping from a line, the pressure in that line will be affected by any change in the size and shape of the outlet through which it is escaping. This variation in pressure is made use of to change the level of mercury in a U-tube for the purpose of closing contacts—that is, for controlling feeds and other machine movements.

The accompanying illustrations show two typical set-ups of the device as applied to external and to internal grinding. In the case of the former, the air outlet is between two diamond points against which the work rests lightly. As grinding proceeds, the sizing head swings slightly upward, decreasing the gap between the work and the orifice. As a result, pressure gradually builds up in the line, causing the mercury in the U-tube to rise until, just before the work is finished, an electric circuit is completed. This energizes a solenoid that slows down the feeding-in movement. Grinding goes on until the prescribed size is reached. Then the mercury, which has continued rising, completes a second circuit and energizes another solenoid which causes the wheel to move rapidly away from the work. The positions of the two contacts in the U-tube can be shifted, and the rate of speed of the grinding feed controlled to meet requirements. The entire sizing head is adjustable in its bracket. In the case of internal grinding, the operations are much the same as those just described other than that the gap between the air outlet and the work increases and the pressure in the line drops.

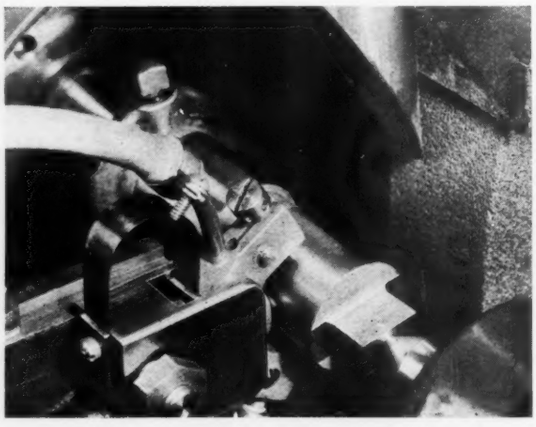
Compressed air of from 2 to 20 pounds pressure per square inch is used; and this may be taken from any shop line, as the control box is provided with valves capable of reducing it to the desired pressure. An air filter is interposed in the line to catch any foreign matter that might otherwise obstruct the outlet.



SET-UP FOR INTERNAL GRINDING

According to the manufacturer, the device readily sizes external surfaces no matter whether they are straight, tapered, radial, splined, keywayed, or only half diameters, and internal holes that are straight, tapered, splined, keywayed, interrupted, or blind. It also serves in the case of radial internal surfaces, thus making it suitable for grinding raceways. Because of the nature of the latter operation it is necessary, while the work is being changed, to swing a part of the sizing head out of the way. To do this without each time breaking the air connection, a diamond-tipped finger, with an up-and-down movement under spring tension, is in contact with the raceway all the while grinding is in progress. To the top of this finger is attached a block which moves as the finger moves, regulating the air gap thus formed between the block and the air outlet, which is carried on the stationary end of the sizing head.

The Landis air-sizing device lends itself to innumerable applications other than those referred to; can be set up quickly; and its limits of accuracy are said to be well within .00025 of an inch.



SET-UP FOR EXTERNAL GRINDING

This and That

World's Oldest Industry

The first manufacturing ever done, scientists believe, was the making of pottery. As they reconstruct history, a primitive man one day shaped a piece of moist clay in which to heat some water. He placed the vessel on a bed of hot coals and dozed. When he awakened, the water had boiled away and the clay had been baked hard into an enduring cup. In some such way, they think, the ceramic industry began. The oldest written records we know of are on clay tablets. The Chinese knew how to make exquisite pottery 10,000 years ago. Ancient and modern methods of making pottery will be contrasted this year at an exhibit at the continuation of the Century of Progress Fair in Chicago. San Ildefonso Indians from the Southwest, using their own desert clay, will demonstrate their art and will live in adobe houses of their own construction. In another portion of the building, the Haeger Potteries, Inc. of Dundee, Ill., will turn out 6,000 pieces of ware a day in an up-to-date plant. Glass-making, which has received a new impetus with the return of legal liquor, will also be shown, as will the manufacture of porcelain, terrazzo, and mosaics.

Elusive Ore Bodies

The Cresson Mine, largest gold producer in the Cripple Creek District of Colorado for a number of years past, is unusual in that its ore bodies do not reach the surface at any point. There is practically no evidence of mineralization within 300 feet of ground level. As a result, the Cresson was not discovered until other famous mines in the camp had reached their production peaks and were on the down grade. The Cresson ore occurs in association with a local crater within the main Cripple Creek crater. Since operations were started in 1903, the Cresson has produced $34,352,047 in gold and has paid $12,405,672 in dividends. Over the 31-year period the ore has averaged $11.87 in gold to the ton.

Safe Lifting Loads

The National Safety Council is seeking to show that the number of lost-time accidents in industry can be very materially reduced by limiting the loads workmen are required to lift. Preliminary studies indicate that there is a direct connection between injuries and the handling of inordinately heavy burdens. The investigations were prompted by an analysis of a report, for New York State, which showed that 21 per cent of all lost-time construction accidents during the course of a year occurred as a consequence of handling heavy and bulky objects. In all, more than 5,000 injuries were sustained under such circumstances.

The conclusion reached from one study of this nature was that, under the most favorable conditions—that is, with the load on the shoulders, a man can carry about 40 per cent of his weight most efficiently. For a man of average size, a safe load would, accordingly, appear to be approximately 65 pounds. A California ice company, whose employees are specially picked for physical size and fitness, recently reduced the maximum allowable load from 150 pounds to 100 pounds and practically eliminated all strains arising from handling ice. In this case, it was determined that most injuries and strains were sustained when a block of ice was being picked up or put down, rather than when it was being carried.

Compressed Air Checks Pneumonia

Compressed air may become a recognized and approved agency in fighting lobar pneumonia. When injected into the lungs of a sufferer, its indicated effect is to aggravate the illness and to hasten the crisis. This is desirable, as the patient's strength and general condition are better able to meet the demands upon them than if the disease were permitted to run its normal course.

Reporting before the American College of Physicians, Dr. Simon S. Leopold, of Philadelphia, stated that experiments conducted on animals showed that the crisis could be advanced two days. Of 36 dogs which were infected with pneumonia eighteen were given the air treatment, and all but three recovered. Only five of the eighteen not so treated survived. In Europe, according to Doctor Leopold, this method has been successfully applied to human pneumonia patients ranging from six weeks to 62 years old. Only three deaths occurred among 50 persons so treated.

"Come on, Rudy! You're on the air this afternoon."

Electric Watch Regulator

Watches and clocks can now be regulated by electrical means in a few minutes instead of in days. This sounds too good to be true; but the information comes from the Bell Telephone Laboratories and, therefore, must be accurate. The timer was produced there, and works on the principle of the stroboscope, an instrument for observing the successive phases of a periodic motion by the use of a light that is periodically interrupted.

The balance wheel of the timepiece to be regulated is reflected on a mirror, permitting a comparison of its speed with the flashes of light from a lamp. When it has been adjusted until it appears to be at a standstill, then the watch is running correctly. The device is also arranged so that the number of seconds gained or lost in a day can be read directly. The electric timer at the Bell Telephone Laboratories obtains its power from a 100-cycle generator in the company's plant. The frequency of the current, which is transmitted to it over telephone wires, is accurate to 1 part in 10,000,000.

CWA Starts a Museum

Everybody knows, but few believe, the old story of the helpful husband who painted himself into an exitless corner of the kitchen while giving the floor a fresh coat of shellac. Yet, such things do happen, as the following facts attest. At Marinette, Wis., CWA workers were employed to construct a concrete basement for a new school building. Oconto County put at their disposal a fine new concrete mixer. As work proceeded, winter descended, so the men moved the mixer into the basement and kept right on pouring concrete. As you have already guessed, they neglected to leave an opening through which the mixer might be removed. So it appears that it will stay there for posterity to ponder over.

New Use of Eiffel Tower

The largest thermometer in the world now occupies a place on one side of the Eiffel Tower in Paris. A red line, electrically actuated, moves up and down the lofty steel skeleton and indicates the temperature on a Centigrade scale. A year ago, the world's largest clock was installed in the tower. When this 984-foot structure was erected for the exposition of 1889, few people believed that it would fill any useful purpose, but a great many ways have been found to make it serve mankind. In addition to being the best vantage point for viewing Paris, it houses a radio station, a weather-observation station, and well-patronized restaurants and shops.

Industrial Notes

On January 1, 1934, according to the Geological Survey, the hydro-electric plants of the United States had a total capacity of 15,913,451 hp. This represents an increase over last year of 95,500 hp., or 20 per cent of the nation's water-power resources.

Skin-Gard is the name given to a creamy paste that, when rubbed on the hands and face before work, will protect the skin against dirt, soot, grease, paint, ink, etc., etc., as well as against the harmful action of acids or other chemicals. The film with its accumulation can be washed off easily in the usual manner.

"Eternite" is the name of a new flooring that is made of portland cement and asbestos fiber. It is the product of the Ruberoid Company, of New York City, and is said to be highly resilient and proof against moisture, fire, and many chemicals and, therefore, especially suitable for industrial purposes. The material is available in gray, red, jade green, buff, and blue.

A new lead-thread lubricant is announced by the Armite Laboratories of Los Angeles, Calif. It consists of a finely divided metallic lead in paste form and is said to be unusually effective in assembling machinery and in repairing equipment subjected to heavy duty and high temperatures. It is spread in the form of a film between the threads, and does not oxidize nor harden even under a bright red heat. The compound is well suited for use with stud bolts and exhaust studs and facilitates the removal or insertion of liners and flywheels.

Great Britain's oldest industry—the quarrying and manufacture of flint—is still being pursued on a small scale in Brandon, Suffolk, where its foundation was laid probably 2,500 years ago. Through the centuries the stone has been used variously in the making of arrow- and spearheads, axes, hammers, plow breasts, chisels, "strike-a-lights," and, finally, of gun flints. It is the demand for the latter, though small, that is keeping the industry alive today; and it is said that all the men now engaged in their production are descendants of the flint workers of those ancient days.

The use of single- and double-drum electric "Tugger" hoists is described in detail in a 38-page, illustrated catalogue, No. 1860-B, published recently by Ingersoll-Rand Company, 11 Broadway, New York City. These hoists are employed extensively in connection with scrapers in mines, quarries, cement mills, on shipboard, and elsewhere for slushing and loading ore, coal, clinker, crushed rock, slag, and other bulk materials. A copy of this bulletin will be furnished free upon request, and should prove suggestive to the mine operator, the construction man, the road-builder, and the maintenance engineer.

A Trip through the Oil Lands of Europe and Asia is the title of the latest moving picture which the U. S. Bureau of Mines has added to its film library. It is a silent movie in three parts and brings to view, first, the oil fields of Germany, France, Spain, Morocco, and Algeria; second, those of Italy, Hungary, and Rumania; and, third, those of Poland, Greece, and Egypt. All of them include scenes of historical and commercial interest, and show something of the life and customs of their inhabitants. Copies of the 8-reel film, in either the 16-mm. or 35-mm. size may be borrowed by schools, churches, clubs, civic and business organizations, etc., from the Pittsburgh Experiment Station, U. S. Bureau of Mines, Pittsburgh, Pa. The only cost involved is that of transportation.

Sandpapers are being made by a new electrocoating process that is said to increase their efficiency anywhere from 20 to 60 per cent, depending upon the material being surfaced. By this method the abrasive particles are brought into an electrostatic field which causes them to stand upright and arranges them uniformly in close formation. In this condition, they are hurled like so many arrows against the glued surface and firmly embedded in the paper. Because of this and the manner in which they are spaced, and also because the abrasives present the best cutting edges to the work, these coated sandpapers are said to cut faster than the old ones, to require less effort, to stand up longer under hard service, and to produce better results. They come in all the grades and varieties required for hand and machine operations.

When a big 210,000-pound locomotive of the Chicago, Burlington & Quincy Railroad was derailed not long ago on a curve in the Chicago district, a pair of pneumatic jacks was instrumental in getting it back and restoring the line to service comparatively quickly. It was feared that the use of ordinary rerailers, over which the heavy engine would have had to be pulled either forward or backward, would have resulted in considerable damage to the track structure, if not to the locomotive, itself. It was therefore decided to try what could be done with pneumatic jacks, of which two were available in the nearby Burlington engine house. These were of the Duff-Norton type with built-in air motors, and had a capacity of 75 tons each. One pair of wheels was thus raised at a time and the rails aligned under them, the jacks taking the compressed air necessary for this work from the train's supply.

Experience has led the water engineer of Singapore to reach the conclusion that rubber is an excellent material for water mains that must withstand continual submergence. He bases his opinion on the service of two such mains—an 8-inch reinforced-rubber conduit that crosses a river in Maryland, and a 4-inch armored-rubber pipe with which he is experimenting. The latter is connected with the regular city water supply, and is kept under a constant pressure of 45 pounds per square inch. After almost two years of submergence it was found to be in excellent condition and withstood a pressure of 100 pounds without leakage. The connection, however, had to be replaced every four months or less, depending upon the type used, because of failure. The main has been again lowered to the bottom of the sea and is linked to the water-supply system by a copper instead of an iron connection.

GOOD MINERS, GOOD BALL PLAYERS

Springtime and baseball are more or less synonymous, so the picture above is in keeping with the season. It shows the Lyon Mountain (New York) baseball team of the Chateaugay Ore & Iron Company, 1933 champions of the Northern New York League. Most of the players are miners and handle a rock drill as skillfully as they do a baseball. They thought it fitting, as typifying their work, to include two modern "Jackhamer" drills in the picture.